



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

### Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

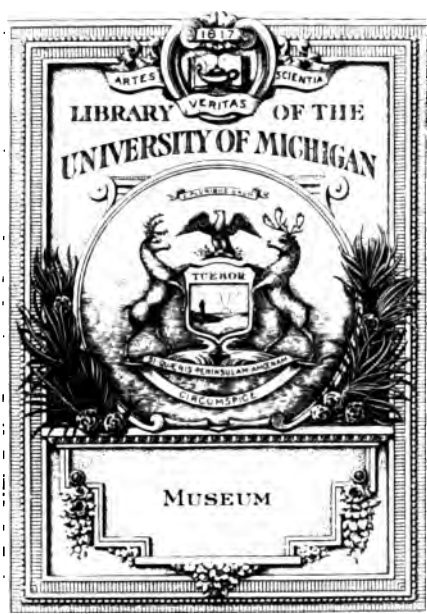
- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

### About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

B 1,280,808





SH

259

.A3

7







TWENTY-FOURTH  
ANNUAL REPORT  
OF THE  
FISHERY BOARD FOR SCOTLAND,

Being for the Year 1905.

IN THREE PARTS.

PART I.—GENERAL REPORT.

PART II.—REPORT ON SALMON FISHERIES.

PART III.—SCIENTIFIC INVESTIGATIONS.

---

PART III.—SCIENTIFIC INVESTIGATIONS.

---

Presented to both Houses of Parliament by Command of His Majesty.

---



GLASGOW:  
PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE  
By JAMES HEDDERWICK & SONS LIMITED,  
At "THE CITIZEN" PRESS, ST. VINCENT PLACE.

And to be purchased, either directly or through any bookseller, from  
OLIVER & BOYD, EDINBURGH; or  
WYMAN & SONS, LTD., FETTER LANE, E.C., and  
32 ABINGDON STREET, WESTMINSTER, S.W.; or  
E. PONSONBY, 116 GRAFTON STREET, DUBLIN.

1906.

[Cd. 8199.] Price 4s. 7½d.

## CONTENTS.

	PAGE
GENERAL STATEMENT, . . . . .	5
Trawling Investigations, . . . . .	6
The Hatching and Rearing of Food Fishes, . . . . .	7
Scientific and Technical Instruction to Fishermen, . . . . .	8
Investigations on the Herring Fisheries of the Firth of Clyde, . . . . .	10
The Chemical Composition of the Herring, . . . . .	12
The Rate of Growth and the Age of Herrings, . . . . .	12
The Rate of Growth and the Age of Food Fishes, . . . . .	13
The Tay Sprat Fishery, . . . . .	14
The Specific Characters of certain Species of the Codfish Genus, . . . . .	14
The Otoliths or Earstones of Fishes, . . . . .	15
The Spawning and Fecundity of the Plaice, . . . . .	15
The Spawning of the Lumpsucker and the Paternal Guardian-ship of the Eggs, . . . . .	16

### SCIENTIFIC REPORTS.

I. Trawling Investigations. By Dr. T. Wemyss Fulton, F.R.S.E., Superintendent of Scientific Investigations, . . . . .	17
II. Observations on the Otoliths of some Teleostean Fishes. By Thomas Scott, LL.D., F.L.S. (Plates I.-V.), . . . . .	48
Preliminary Remarks, . . . . .	48
List of Fishes whose Otoliths are described, . . . . .	52
Systematic Description of the Otoliths, . . . . .	53
Literature bearing on the Otoliths of Fishes, . . . . .	80
III. The Food Value of the Herring. By T. H. Milroy, M.D., B.Sc., F.R.S.E., Professor of Physiology, Queen's College, Belfast, . . . . .	83
Previous Analyses of Herrings, . . . . .	83
Methods of Analysis, . . . . .	85
Analysis of May Lochfyne Herrings, . . . . .	86
„ July Lochfyne Herrings, . . . . .	88
„ September Lochfyne Herrings, . . . . .	89
„ October Lochfyne Herrings, . . . . .	89
„ November Lochfyne Herrings, . . . . .	92
„ December Helmsdale Herrings, . . . . .	93
„ „ Lochfyne Herrings, . . . . .	94
„ „ Lochboisdale Herrings, . . . . .	95
„ February Lochboisdale Herrings, . . . . .	96
Tables of Ratios, . . . . .	97
Summary of Results, . . . . .	101
Remarks on Nutritive Value of Spent Herrings, with some additional Tables illustrating Differences in Composition of these Fish, . . . . .	103

D.L. 17.



	PAGE
IV. Report on the Operations at the Marine Fish Hatchery, Bay of Nigg, Aberdeen. By T. Wemyss Fulton, M.D., F.R.S.E., Scientific Superintendent. (Plates VI.-VII.),	108
V. On the Specific Characters of <i>Gadus luscus</i> , <i>Gadus minutus</i> , and <i>Gadus esmarkii</i> . By H. Chas. Williamson, M.A., D.Sc. (Plates VIII.-X.),	116
Introduction,	116
List of Body Dimensions,	119
List of Enumeration Characters,	121
Discussion of the Averages,	121
The Numbers of Fin-Rays,	126
The Numbers of Vertebrae,	129
The Reproduction of the Three Species,	130
The Skulls of the Three Species,	131
General Comparison between the Three Species,	133
A Specific Description,	135
VI. On the Tay Sprat Fishery, 1905-1906. By John Fletcher,	159
VII. On the Spawning of the Lumpsucker ( <i>Cyclopterus lumpus</i> ) and the Paternal Guardianship of the Eggs. By T. Wemyss Fulton, M.D., F.R.S.E. (Plate XI.)	169
VIII. On the Rate of Growth of Fishes. By T. Wemyss Fulton, M.D., F.R.S.E. (Plates XII., XIII.),	179
Introduction,	179
Species dealt with,	179
Methods,	180
Comparison between Different Species,	180
Influence of External Conditions,	181
A Law of Growth,	182
Plaice ( <i>Pleuronectes platessa</i> ),	184
Common Dab ( <i>P. limanda</i> ),	189
Flounder ( <i>P. flesus</i> ),	191
Lemon Dab ( <i>P. microcephalus</i> ),	192
Long Rough Dab ( <i>Drepanopsetta platessoides</i> ),	196
Turbot ( <i>Rhombus (Bothus) maximus</i> ),	199
Brill ( <i>Rhombus levis</i> ),	203
Cod ( <i>Gadus callarias</i> ),	209
Haddock ( <i>G. aeglefinus</i> ),	226
Whiting ( <i>G. merlangus</i> ),	229
Grey Gurnard ( <i>Trigla gurnardus</i> ),	232
Tables of Measurements, I.-XXV.,	243
IX. Notes on New and Rare Copepoda from the Scottish Seas. By Thomas Scott, LL.D., F.L.S. (Plate XIV.),	275
X. On the Spawning and Fecundity of the Plaice ( <i>Pleuronectes platessa</i> ). By T. Wemyss Fulton, M.D., F.R.S.E., Superintendent of Scientific Investigations,	281
XI. On Two Cases of Hermaphroditism in the Cod ( <i>Gadus callarias</i> ). By H. Charles Williamson, M.A., D.Sc., Marine Laboratory, Aberdeen. (Plates XV., XVI.),	290

	PAGE
XII. On the Growth and Age of the Herring ( <i>Clupea harengus</i> ). By T. Wemyss Fulton, M.D., F.R.S.E. (Plates XVII.-XIX.),	
1. Previous Opinions and Observations, . . .	293
(a) English Authors, . . .	293
(b) Scandinavian and Dutch, . . .	294
(c) Meyer and Jenkins, . . .	295
(d) Masterman and Cunningham, . . .	298
2. The Size of the Herring when it first attains Maturity, . . .	299
3. The Maximum Size attained by the Herring, . . .	301
4. The Spawning-Periods of the Herring, . . .	302
5. The Duration of Embryonic Development : Rela- tion to Temperature, . . .	303
6. A Criticism of Meyer's Conclusions and Observations, . . .	304
7. The Scottish Collections, . . .	307
(a) Larval and Post-larval Stages, . . .	308
(b) The Annual Groups, . . .	323
8. Conclusions, . . .	334
9. Literature, . . .	338
10. Description of Plates, . . .	338

# TWENTY-FOURTH ANNUAL REPORT.

---

TO THE RIGHT HONOURABLE  
JOHN SINCLAIR, M. P.,  
*His Majesty's Secretary for Scotland.*

---

OFFICE OF THE FISHERY BOARD  
FOR SCOTLAND,  
EDINBURGH, 30th August 1906.

SIR,

In continuation of our Twenty-fourth Annual Report,  
we have the honour to submit—

## PART III.—SCIENTIFIC INVESTIGATIONS.

---

### GENERAL STATEMENT.

This, the third part of the Twenty-fourth Annual Report, deals with the scientific investigations conducted by the Board in 1905, so far as they have been completed, by means of the Parliamentary Vote granted for the purpose.

The scientific work has, as usual, been carried out under the supervision of Dr. T. Wemyss Fulton, the Scientific Superintendent under the Board, the researches having been for the most part undertaken at the Marine Laboratory at Aberdeen, in the Moray Firth, and the Firth of Clyde. The sea-fish hatchery, which is also situated at Aberdeen, was reconstructed during the year in connection with the formation of a new road at the Bay of Nigg by the Town Council of Aberdeen and at their expense, as described below, where a statement of the hatching operations will also be found.

In the Firth of Clyde, and more particularly in Lochfyne, an investigation into the natural history and migrations of the herring was continued, with the view of ascertaining if possible the cause of the decline in the yield of the herring fishery there in recent years, and whether any regulations affecting the time or methods of fishing would be likely to be beneficial to the fishery as a whole. As stated in the first part of this Report, the catch last year was

one of the poorest on record, the shortage on the previous year's catch, which was much below the average, amounting to 3160 crans in quantity and £6243 in value. The work has been done as far as was possible by the use of fishing boats and the hire of a small yacht for monthly observations within the loch itself, and this had to be interrupted during the winter.

The investigations into the condition of the fishing-grounds in the Moray Firth were made as far as possible by the use of commercial trawlers, without expense, as referred to more fully below, and the observations on the growth, reproduction, and distribution of the edible fishes continued as in the last few years, as well as those on the destruction and capture of immature and undersized fishes. Owing to the unfortunate stranding of one of these vessels in Aberdeen Bay last December, while engaged in procuring plaice for the hatchery-ponds, and the loss of life occasioned thereby, the Board have thought it right to refrain from making use of such vessels for inshore work in future.

As mentioned later, the Board has been pleased with the favourable response of seaboard County Councils to their invitation to send fishermen to the Marine Laboratory and Hatchery at Aberdeen for a week's instruction, each spring, in the life-history of fishes, and they hope that the facilities offered may be still further taken advantage of.

#### TRAWLING INVESTIGATIONS.

During the last few years, since the *Garland* was disposed of, the fishing grounds in certain parts of the territorial waters, especially in the Moray Firth and Aberdeen Bay, have been examined from time to time by means of commercial steam-trawlers, whose services were obtained without expense, partly with the view of ascertaining their condition and partly for the purpose of scientific research on the reproduction, growth, and distribution of fishes, and the capture of immature or undersized fish. A number of papers embodying the results of this work have already been published in previous Annual Reports. In the present Report there are two containing further observations by Dr. Fulton, one on the growth of fishes, referred to later, and the other furnishing an account of the trawling experiments last year, with detailed tables of the fish captured and the proportions which were unmarketable.

The more important areas in the Moray Firth were visited in February, September, October, and November, and the grounds in Aberdeen Bay were also examined in March. The aggregate quantity of fish brought to the market in the various trips was 388½ cwts., and the total number of fishes caught in the recorded hauls was 71,982, of which 41,444, or over 59 per cent., were unmarketable.

On most of the occasions marketable fish were by no means plentiful, and the voyages were not very profitable financially. This was particularly noteworthy in the Moray Firth in the autumn months, at which time the vessels working on the offshore grounds in the North Sea were much more successful. Haddocks

of marketable size were exceedingly scarce, the total catch of these being under twenty boxes for all the trips together, and more than half of them were obtained in February; in September they totalled five boxes, and in November a box and a half.

On the other hand, immense shoals of young haddocks, under two years of age, were present in the bays in autumn, from which they were absent in the spring, and by far the greater part of those taken were thrown overboard as unmarketable.

Some of the hauls may be referred to as showing the enormous destructive power possessed by the modern otter-trawl when employed in shallow bays at certain seasons. In six hauls in the Dornoch Firth at the end of September, the duration of the actual fishing being  $23\frac{1}{2}$  hours, 25,563 fishes were caught, and of these, 18,809, or  $73\frac{1}{2}$  per cent., were thrown overboard as unmarketable. The number of haddocks taken in these six hauls was large, viz., 10,361, but only 394 of them were large enough to be marketable, 96 per cent. of the catch being returned to the sea. The prevalence of the small haddocks on the ground in autumn, and their scarcity in spring, may be shown in another way. While in February it took ten hours' trawling to catch one unmarketable haddock and two marketable, the number of the former taken in the same time in September was 4196 and of the latter 166. The capture of small unmarketable plaice was also very considerable on this ground in autumn, 54 per cent. of the 13,610 plaice caught in the six hauls being rejected on account of their small size.

All the young haddocks and a large proportion of the young plaice caught in this way perish, although under favourable conditions many of the latter may be preserved.

It was shown formerly by similar investigations on board commercial trawlers fishing on the deeper grounds in the North Sea that the percentage of small fish taken there was less than in the waters near shore. In the Moray Firth in February the proportion of the unmarketable was 19 per cent., and in autumn it was 67 per cent.

Observations were also made on the maturity and growth of the fishes caught, and a number of experiments were carried on with small-meshed nets.

#### THE HATCHING AND REARING OF PLAICE.

Owing to the formation of a new road at the Bay of Nigg last year, the Town Council of Aberdeen, from whom the site of the hatchery is leased, desired that that building and some others might be transferred to an adjoining part of the ground and re-erected at their expense. To this proposal the Board agreed, and the hatchery, the boiler and pump-house, and the storehouse were accordingly taken down and rebuilt on the new site.

The change involved considerable re-arrangement of the pipes, &c., and the opportunity was made use of to effect some improvements which experience had shown to be desirable. The Town Council gave all reasonable facilities for the alterations and improvements being carried out, so that the hatchery is now better adapted for the work than it was before. The building itself is

now somewhat enlarged; a concrete floor replaces the old wooden one; a strong wall has been built along the seaward face of the site, and granite retaining walls around the gravitation tank. In the present Report a brief description is given of the hatchery as rearranged, with illustrations showing the interior and exterior, the pumping plant, and the large spawning-pond in which the breeding fishes are kept and where the eggs are shed at the spawning season.

During last year the eggs of the plaice were first discovered in the pond on 20th January, about the usual date when they make their appearance. Collections of eggs were thereafter obtained almost daily. The numbers gradually increased until the middle of March, after which they declined until 16th May, when the last collection was made. The duration of the spawning in the pond was thus about 117 days, which may be regarded as approximately the period in the sea. The aggregate number of eggs collected in the season was estimated at 40,110,000, of which 48 per cent. were spawned in March, 23 per cent. in February, and the same proportion in April.

The duration of the period of embryonic development, until the eggs hatch, varies with the temperature of the water. The average at the beginning of the season, when the temperature is low, is about three weeks; towards the end of the season, with the temperature some degrees higher, hatching takes place in about a fortnight. The larval fishes, on issuing from the eggs, are retained in the apparatus for several days until the yolk-sac is partly absorbed, and it is calculated that the eggs and larvæ are protected in this way for about half of the time from the spawning of the eggs until the young plaice undergo their metamorphosis and assume the form and habit of the adult.

The estimated number of fry which hatched out and were placed in the sea was 24,500,000. Most of them were distributed off Aberdeen, but one lot of about three and a half millions was taken to St. Combs, further up the coast, at the request of the fishermen, and there distributed.

Since the establishment of the hatchery the total number of the fry of plaice which have been set free in the sea amounts to 387,750,000, the number of fry of other fishes, as turbot, lemon dabs, and cod, being close upon 17,000,000.

Owing to the circumstance that the hatchery is worked in conjunction with the Marine Laboratory, the expense of the hatching operations is comparatively small, the annual expenditure being estimated at rather under than over £100, which meets the cost of extra coal and an additional assistant at the height of the season.

#### SCIENTIFIC AND TECHNICAL INSTRUCTION TO FISHERMEN.

For some years past, as mentioned in previous Reports, by an arrangement with the Technical Education Committee of the County Council of Aberdeenshire, representative fishermen from various parts of the coast of that county have visited the laboratory and hatchery in spring, to attend demonstrations on the life-

history and habits of fishes, such as might be of interest and use to them, and to see the processes of fish-hatching.

The fishermen were so much interested in the instruction they received that, in some instances, on returning home, they held public meetings to discuss and communicate what they had learned; and as it appeared to the Board desirable to encourage this inclination among the fishing population for knowledge of the kind, they invited other seaboard County Councils to send fishermen to the demonstrations, if they felt so disposed, no expense being incurred except for the travelling and maintenance of the men. The response has been gratifying, fishermen from the counties of Argyll, Bute, Caithness, and Elgin having attended the last course of instruction.

The subjects taught include the life-history of such fishes as the herring, cod, haddock, and plaice, as well as of the mussel and edible crustacea, the instruction being given in as simple a manner as possible. The food, reproduction, growth, &c., of fishes are explained and illustrated by specimens and experiment, and the men are shown the process of fertilisation and the development of a fish within the egg. Demonstrations are also given on various methods of "barking" nets and lines, a subject which, touching as it does on their daily occupation, is always interesting, and the opportunity is taken to show them some of the fish-curing and ice-making establishments in Aberdeen, as well as the fish-market.

With reference to the "barking" of nets, it may be stated that experiments are being tried as to the relative value of certain methods for the preservation of herring-nets, and that the Congested Districts Board have courteously agreed to defray the cost, and to have the trial of the nets made on board the experimental motor-fishing boat *Pioneer*.

It may be worth stating that on the whole question of the technical education of fishermen and those engaged in the fishing industry most other countries in Europe are in advance of ourselves. In France and Germany there are a number of schools devoted to this work, directly or indirectly under the patronage of the State; there are several in Denmark, The Netherlands, Belgium, and Sweden. Most of them are concerned chiefly with that part of a fisherman's knowledge which relates to navigation, fishing-grounds, and actual fishing, but many offer elaborate facilities for instruction of a more purely scientific kind, and are provided with laboratories, museums, libraries, and a teaching staff; some have ships as floating schools for practical work. By far the most important and the best-equipped institution of the kind is the Imperial Fisheries Institute at Tokio, Japan, which was recently rebuilt by the Japanese Government at a cost of £17,000. The buildings and grounds occupy 8½ acres, including a dock for the experimental vessels; there are sixteen lecture rooms, as well as laboratories, museum, and libraries; the staff includes ten professors and many assistants; and the course, which is divided into three sections—fishing, fisheries technology, and pisciculture—extends over three years. The aim is to educate the young Japanese connected with the fishing industry in the most thorough and scientific manner; but much work is also done in training teachers

for the local fisheries and technical schools, and men who wish to devote themselves to such industries as canning and curing fish, the manufacture of fish-oils, iodine, &c.

In this country there is perhaps room for a more thorough scientific and technical training in connection with the treatment and curing of fish than now obtains.

#### INVESTIGATIONS ON THE HERRING FISHERIES IN THE FIRTH OF CLYDE.

The investigations on the herring fisheries in the Clyde refer chiefly to Ballantrae Bank and Lochfyne. With regard to the former, where a Bye-law (No. 18) is in operation interdicting seine-net fishing within a certain area, the fishery last season, as for some years past, was a failure, the weather having been almost continuously stormy up to the middle of March. The Fishery Officer reports that, although the "appearances" of herrings on the bank were as good as ever they were before—that is, the presence of whales, solan geese, and the oily look of the surface, by which fishermen judge of the location of herring-shoals—and though it was conclusively proved that herrings visited the ground to spawn by the fact that the gill-nets set for cod were coated with herring-eggs, the total quantity of herrings taken was 383 crans—15 by drift-nets, 83 by seine-net, and 285 by "trammels" or set-nets. No observations were thus possible as to the herring at Ballantrae; and, owing to the want of a steamer, equipped for such work, dredging operations on the bank could not be undertaken.

The fact that shoals of herrings have continued to frequent these grounds every spring in recent years, and have been scarcely at all disturbed by the action of the nets of fishermen, while the Lochfyne fishing has been extremely unsuccessful, does not lend support to the theory, strenuously held a few years ago, that the seine-net fishing at Ballantrae was injurious to the fishing in the loch; though sufficient time has not yet elapsed to make this certain.

The investigations in Lochfyne concern the decline in the yield of the fishery in recent years, especially in 1904 and 1905, the latter being amongst the worst years on record, and are designed to throw light on the movements of the herring-shoals into and out of the loch, the places where the herrings spawn and the periods, the relation of the abundance of food-material in the loch to the abundance of the herrings, the growth of the herring, and the great fluctuations that occur. An investigation of this kind is difficult under the most favourable circumstances and must necessarily cover several successive seasons. As much as possible has been done by the hire of boats; monthly observations on the temperature and food-material for the herring have been made for over a year, but they had to be suspended during last winter, owing to the lack of funds to meet the expenses.

In addition to the information afforded by the course of the fishing and the places of capture of the fish, two methods have been adopted with the object of tracing the migrations of the herring. One consists in marking the herrings with a printed silk



tag, suitably treated, and then liberating them, and over 500 herrings have been thus dealt with. The tag contains directions to the finder and enables the particular herring to be identified. So far, five of the marked herrings have been caught again, but as they were caught within the loch, and not far from the place of liberation, they do not afford evidence as to the route of the herrings from the loch or their destination. The herring is much more delicate than ordinary round fishes and flat fishes, as plaice and cod, which are made the subject of similar experiments, and it was found necessary to attach the tag to them while they were still in the water within the bag of the seine-net. This method will be persevered in, since the recovery of a single marked herring at a distance from the place of liberation, particularly if it is caught at a spawning-ground and about the spawning-time, affords direct and conclusive evidence as to the migration of that particular herring, and presumptive evidence as to the movement of the shoal to which it belongs, since the individuals composing it are governed by a common object, namely, reproduction.

The second method consists in the attempt to identify a particular shoal by a study of the characters of the herrings belonging to it. It was applied in particular to the large and fine fish which loiter till near the end of the year in the deep water of the upper loch, which they quit by easy stages, and are believed, and probably rightly, to make their way down Kilbrennan Sound to spawn in the early months of the year somewhere off the southern part of Kintyre. Many hundreds of these herrings were examined at different periods, weighed, various measurements tabulated, and the condition and weight of the reproductive organs determined; the latter observations affording incidentally valuable information as to the ripening process and its duration. These herrings were traced down the loch at the end of the year, and they appear to have gone down Kilbrennan Sound, but, owing to the absence of the Fishery Officer at Campbeltown on other duties, sufficient samples of the herrings being caught in the early part of the year could not be procured. It is accepted as a working hypothesis that these large herrings pass down Kilbrennan Sound, but there is not conclusive evidence to show that they do so.

In the meantime, it may be pointed out that in the past the fluctuations in the yield of herrings in Lochfyne in different years have been noteworthy, as the following Table, which covers the long period of half a century, shows:—

Ten Year Period.	Average Number of Boats.	Average Number of Barrels Taken.	Average Number of Barrels per Boat.	Minimum Catch in Decade.	Maximum Catch in Decade.
1827-36, . . .	300	3,469	11·5	Barrels. 1,453 (1830)	Barrels. 4,898 (1832)
1837-46, . . .	350	7,388	25·1	3,225 (1839)	9,400 (1846)
1847-56, . . .	396	19,949	50·4	10,630 (1852)	32,726 (1851)
1857-66, . . .	558	33,096	59·3	16,151 (1864)	79,893 (1862)
1967-76, . . .	479	25,561	53·4	6,984 (1874)	34,471 (1876)

## THE FOOD-VALUE OF THE HERRING.

As part of the series of researches now being carried out by the scientific department of the Board on the herring and herring fisheries, it was decided to obtain analyses of herrings in order to determine their composition and food-value at different periods of their development, especially when ripe or nearly mature and when spent. This investigation was undertaken by Dr. T. H. Milroy, Professor of Physiology, Queen's College, Belfast, who furnishes an important paper on the subject which is contained in the present Report, the detailed analyses being set forth in numerous Tables. Herrings have been analysed before, but the results have shown much discrepancy from the fact that the season of the year or the sexual development of the fish has been ignored. Professor Milroy shows that great differences in the muscle of the herring exist at different periods, even when the herrings are taken from the same waters. The herrings used for the research were obtained principally from Lochfyne, but also from Lochboisdale and Helmsdale.

The composition of the herrings is stated in terms of water, proteid, fat, and phosphoric acid, and as the muscle or flesh constitutes the main source of the nutritive value of the herring, it is important to recognise the variations in its composition. These are most striking, especially as concerns the percentage of fat, and as this food principle possesses such a high caloric value, any marked decrease in its amount lowers the nutritive value of the fish to a serious extent. The lowest fat-percentage was found in the large spent herrings from Lochboisdale in February, and the total amount of fat present in the collective muscles of the average fish was exceedingly small. In these muscles the percentage of water was higher than normal, but the proteid and phosphorus percentages were but little affected. In Lochfyne, the fat-percentage of the flesh of the herring continues to rise during August, September, and October. It begins to fall slowly in November, markedly in December, most markedly during spawning, and continues at a low level until the fish begin to feed again.

With regard to the nutritive value of spent herrings, Professor Milroy says the statements often vaguely made as to their unwholesome character usually rest upon the general appearance of the flesh, which is undoubtedly poorer in fat. But the nutritive value depends not only upon the fat, but upon the proteids, and the analyses show that in this respect spent herrings compare by no means unfavourably with the maturing or mature fish. Fully mature fish, about to spawn, are in the same condition as freshly spent fish.

A similar research on the composition of the herrings of the east coast of Scotland is now in progress.

## THE RATE OF GROWTH AND AGE OF THE HERRING.

To the present Report a paper is contributed by Dr. Wemyss Fulton on the growth and age of the herring, based upon the measurements and examination during the last six years of nearly

20,000 specimens, which were obtained mostly in small-meshed nets around the cod-end of otter-trawls during the trawling investigations. It is shown that the opinions hitherto generally held as to the growth of this fish, and which are for the most part based on the investigations of a German naturalist, Dr. H. A. Meyer, which were made at Kiel, on the Baltic, over twenty-five years ago, are not well-founded, and that the herring grows more slowly than he supposed.

Dr. Meyer's observations and experiments are submitted to critical examination, the results showing that he over-estimated the growth of the herring in winter, when the growth of all fishes is retarded, and missed at least a year in the computation of its age. The gradual growth of the young post-larval herring from the spring and from the autumn spawning respectively is traced, the latter towards the end of the year being between one and two inches in length, while the growth of the spring herring under more favourable temperature conditions is quicker.

The herring when one year of age measures barely two and a quarter inches in length, and it does not reach maturity and spawn until five years old and of an average length of about  $9\frac{1}{4}$ – $9\frac{1}{2}$  inches. The size of the herring at different ages is approximately as follows :—

Approximate Age.	Length.		Increase in Length from Previous Year.	
	Mm.	Inches.	Mm.	Inches.
1 Year, . . . . .	60·5	$2\frac{3}{8}$	—	—
2 Years, . . . . .	113	$4\frac{7}{8}$	52	$2\frac{1}{4}$
3 „ . . . . .	159	$6\frac{1}{2}$	47	$1\frac{7}{8}$
4 „ . . . . .	200	$7\frac{7}{8}$	41	$1\frac{5}{8}$
5 „ . . . . .	238	$9\frac{3}{8}$	38	$1\frac{1}{2}$
6 „ . . . . .	257	$10\frac{1}{8}$	19	$\frac{3}{4}$

Herrings over twelve inches long, like the large Lochfyne fish, may be ten years old and more, and the very large herrings that are occasionally caught, measuring 14–15 inches, are probably over 15 years of age, and may be 20. Compared with most fishes caught by lines or trawls, the herring caught by drift-nets has a great advantage, since no less than four generations of undersized or immature herrings escape capture by passing through the meshes of the net, and only fish which have reached adult size are taken.

The paper is illustrated with three plates of diagrams.

#### THE RATE OF GROWTH AND THE AGE OF THE FOOD FISHES.

Another paper dealing with the growth of numerous species is contributed by Dr. Fulton, the results being founded upon the measurements of nearly 209,000 fishes belonging to 21 species, which was done almost entirely by means of the commercial

trawlers employed in the trawling investigations, as previously described, and is the same method as that which has since been used so extensively in the course of the international investigations in the North Sea. During the course of the investigation, which has extended over six years, the numbers of the chief species dealt with have been as follows :—

Plaice, . . . . .	17,950	Whiting, . . . . .	58,164
Common Dab, . . . . .	26,230	Gurnard, . . . . .	5,495
Long Rough Dab, . . . . .	20,261	Norway Pout, . . . . .	7,192
Cod, . . . . .	7,176	Herring, . . . . .	19,806
Haddock, . . . . .	28,760	Sprat, . . . . .	6,473

From a study of the growth of the different fishes and the size at which they attain maturity, a law of growth is stated, namely, that fishes approximately double their size and increase their weight about eight times after they have reached sexual maturity.

The species whose growth and age are specially dealt with in the paper are the plaice, dab, flounder, lemon dab, long rough dab, turbot, brill, cod, haddock, whiting, and grey gurnard. A general conclusion is that fishes do not grow so quickly as is generally supposed. Thus, while the plaice reaches a length of about three inches in the first year of its life, the female is five years old and the male four years when they attain maturity. It is estimated that the turbot does not spawn until it is at least seven years old, while the cod spawns at four or five years, the haddock at three, and the whiting when two years of age. The paper is accompanied by a number of tables of measurements and two plates.

In connection with the question of the growth of fishes, a research on the rate of digestion by Dr. Noël Paton, whose investigations on the salmon are so well known, is in progress. Two sets of observations have been made, but the final results are reserved for next year's Report.

#### THE TAY SPRAT FISHERY.

Mr. John Fletcher contributes a paper on the sprat fishery in the Tay, similar to the one published last year, but dealing with the winter of 1905–1906. The fishery was again a comparative failure, only 1371 crans of sprats, including young herrings, being taken. The estimated number of young herrings caught in the sprat fishing is stated to have been nearly 12,000,000, while the sprats are estimated at a little over 16,000,000, the estimated percentage of young herrings amounting to 42·4.

#### THE SPECIFIC CHARACTERS OF THE GADIDÆ.

Dr. Williamson contributes a paper, illustrated with three plates, on the classification of certain members of the cod-family, viz., the bib, or whiting-pout, the poor-cod, and the Norway pout, the paper being a continuation of a previous one, in which the cod, the saithe, and the lythe were dealt with. Two of the species, the whiting-pout and the poor-cod, have often been confused, certain

authors at different times maintaining that they are specifically the same, a circumstance attributed to only a few specimens having been examined, and the specific characters as published ambiguous. By a study of the distinguishing characters and numerous measurements, Dr. Williamson shows that these two species are distinct, and a key is given incorporating the results of the previous and the present researches, by which the six species may be separated. The same naturalist supplies a paper, with two plates of drawings, on hermaphroditism in the cod, a condition which is normal in certain fishes, as the Gilthead (*Chrysophrys auratus*), and occurs occasionally in others.

#### THE OTOLITHS OR EARSTONES OF FISHES.

In this Report will be found a long and elaborate paper by Dr. Thomas Scott on the otoliths or earstones of teleostean or bony fishes, which is illustrated by five plates containing figures of the otoliths described, belonging to about seventy species. The otoliths of different fishes vary remarkably in shape and size, and Dr. Scott shows how these differences may be used as a means for the identification of the various species should other data not be available. It is thus sometimes possible, as the author has shown in previous papers, to tell upon what fishes a particular fish or cetacean may have been feeding, by the presence of the earstones alone. The otoliths consist almost entirely of calcareous matter, only a trace of organic tissue being present. The structure shows that the limy matter is deposited in concentric layers, the density of each layer being slightly greater or less than the one immediately preceding it. In flat fishes, the earstones form round or oval discs, so thin that the alternating concentric layers are easily made out. The number of such layers, or growth-lines, appears to correspond more or less closely with the age of the fish, but Dr. Scott is of opinion from his researches that it is doubtful if the evidence of age obtained in this way can be safely relied on.

The same naturalist also contributes a brief paper on new and rare copepoda from the Scottish seas, illustrated by a plate of drawings. Most of the species were obtained in the Firth of Forth and the Moray Firth.

#### THE SPAWNING AND FECUNDITY OF THE PLAICE.

An experiment was made on this subject by Dr. Fulton, by keeping adult plaice about to spawn in tanks and collecting all the eggs that appeared in the overflow daily, or twice daily. By this means the number of eggs spawned by each of the two females experimented with was determined, as well as the duration of the spawning and the quantity of eggs that appeared from day to day. One of the females spawned steadily, and almost daily for a period of 36 days, the quantity shed at any time being small; the spawning of the other extended over 41 days, but eggs were spawned on only 16 days during the period, large quantities of eggs being shed on each occasion, as many as 49,000. The first

female produced a total of about 163,500 eggs, and the second one a total of 252,700. The eggs of one of the fishes were found to be smaller than those of the other, and towards the end of the spawning the size of the egg became reduced in each case.

THE SPAWNING OF THE LUMPSUCKER AND THE PATERNAL  
GUARDIANSHIP OF THE EGGS.

A paper by Dr. Fulton describes the spawning of the Lumpsucker and the remarkable assiduity with which the male guards the eggs during the period of incubation, which lasts for about two months.

During all this time the male stands sentinel over the eggs, repelling the attacks of intruders, pursuing other males that approach them, constantly aerating them by a movement of his fins, and by spouting currents of water on them from his mouth, and refusing all food until almost the end of his long vigil.

We have the honour to be,

Your most obedient Servants,

ANGUS SUTHERLAND, *Chairman.*

D. CRAWFORD, *Deputy-Chairman.*

D'ARCY W. THOMPSON.

W. R. DUGUID.

L. MILLOY.

D. MEARNS.

H. WATSON.

WM. C. ROBERTSON, *Secretary.*

## SCIENTIFIC REPORTS.

### I.—TRAWLING INVESTIGATIONS. By Dr. T. WEMYSS FULTON, F.R.S.E., Superintendent of Scientific Investigations.

#### INTRODUCTORY.

Last year the investigations into the conditions of the fishing grounds in the Moray Firth and Aberdeen Bay, by means of steam trawlers, whose services were obtained for the purpose without expense, were continued as in previous years as far as circumstances permitted. In the Moray Firth the more important areas were visited in February, September, October, and November, and the grounds in Aberdeen Bay were also examined in March. The grounds at Burghead Bay and in the neighbourhood on the south coast were most fully examined, but a number of hauls were also taken in the Dornoch Firth, off the Sutors of Cromarty, and a few off the Caithness coast.

On most occasions fish were found to be scarce, and the results of the voyages were not regarded as financially profitable by the owners, especially in the Moray Firth in September, October, and November, when the vessels working on the usual grounds in the North Sea were much more successful. Haddocks, in particular, were unusually scarce, only  $19\frac{1}{2}$  cwts. being taken in the whole of the voyages together, and of these  $12\frac{1}{2}$  cwts. were got in the February trip. In September the total quantity of haddocks amounted to only 5 cwts., and in November to  $1\frac{1}{2}$  cwts., while none at all were caught in Aberdeen Bay in March. The haddocks that were taken were mostly small, and in autumn large numbers of these small unmarketable haddocks were brought up in the trawl in the Moray Firth and thrown overboard. On one occasion close upon 4000 were taken in a single haul. Particulars in regard to these are given below, and in the Tables appended. The total quantity of fish of all kinds brought to market in the course of the various trips amounted to  $388\frac{1}{2}$  cwts., mostly consisting of plaice.

With regard to the number of fishes taken, the aggregate for the completely recorded hauls was 71,982, of which 30,538 were marketable and 41,444 unmarketable, either because of their small size, or because they were not of edible kinds. The total number of plaice taken in these hauls was 29,958; the number of haddocks was 26,348, the greater proportion being too small to be marketable, and the number of cod was 302. As showing the quantity of unmarketable fish in autumn as compared with spring (February) it may be said that while at the latter period 12,882 marketable fish were taken as against 3088 unmarketable, in autumn the number of unmarketable was 26,133, while the number of marketable was almost the same as in spring, viz., 12,756.

One of the objects of these trawling investigations is to ascertain as far as possible the changes which occur in the abundance of the food and other fishes on the grounds in different seasons and years; but observations are also made on the reproduction of the fishes, their spawning,

food, &c., while at the same time collections of floating organisms, or plankton, are obtained. The employment of commercial trawlers for this purpose is associated with certain disadvantages, particularly from the point of view of comfort; but as the trawling work is carried on precisely as it is when fishing for market purposes, opportunities are afforded for various observations bearing on this method of fishing, as, for example, the proportion of marketable and unmarketable fishes which are taken, the influence of the size of the mesh on the size of the fish caught, &c. The expense, moreover, is comparatively slight, as no charge is made for the use of the vessels, which are also available for procuring supplies of adult living plaice for the hatchery, without cost.

On some of the occasions the records of the catches on board the trawlers were made by Dr. Williamson.

---

### I.

The first of the trawlings was made in the Moray Firth and Aberdeen Bay from the 6th to the 11th February, the steam-trawler "Loch Lyddoch" being employed; rather heavy weather was encountered during the latter part of the trip. The places visited in the Moray Firth were Burghead Bay and the grounds off it, the grounds in deeper water to the east of the Sutors of Cromarty, and the Dornoch Firth. A gale which sprang up, with a heavy sea, prevented the vessel from visiting Smith Bank and the grounds off the Caithness coast, as was intended.

The first hauls were made in Burghead Bay in the afternoon of 6th February, the wind when the work commenced being from the westwards and light. A drag in from about 5 to 12 fathoms for four hours, and therefore somewhat close in, yielded a total of 596 fish, of which 511 were marketable and 85 unmarketable. The greater part of the marketable catch consisted of plaice, and witches were fairly numerous. The plaice numbered 292, all of them marketable, and most of them medium and small, only 1 large plaice being taken. There were 100 witches, all marketable, and among the other flat-fishes, 3 turbot, 13 brill, 1 halibut, 26 common dabs, and 7 flounders. Round-fishes, especially haddocks, were scarce; they included 2 cod, 7 codlings, 39 haddocks, all but 1 being small, 18 whittings, and 2 cat fish. The unmarketable fishes consisted mostly of common dabs, whiting, and codling. The second haul, in the same locality and about the same depths, was for four hours and five minutes. The number of fishes secured was 792, of which 712 were marketable and 80 unmarketable. Plaice were better represented, the total being 493, all of them marketable, and consisting chiefly of medium and small specimens. This catch also included a halibut, 3 turbot, and 14 brill, as well as 49 witches, all marketable, and 100 common dabs. There were also 7 cod and 11 codlings; haddocks were equally scarce, only 26 being taken. A third haul in the same place gave somewhat the same results. It was for four hours, and the aggregate catch amounted to 863 fishes, 768 being marketable and 95 unmarketable. Plaice formed the bulk of the catch; they numbered 375, mostly small and medium, and there were also 178 witches, all marketable, as well as 37 brill, 79 common dabs, and 5 flounders. The marketable round-fishes included 4 cod, 28 codling, and 43 haddocks, all of the latter, except one, being small.

In the three hauls in this place within the range of depth mentioned, occupying altogether twelve hours and five minutes, 2251 fishes were caught, of which 1991 were marketable and 260 unmarketable. The



particulars are given in the following Table, the marketable fishes being represented on the first line (I.) and the unmarketable on the second line (II.).

	Cod.	Codling.	Haddock.	Whiting.	Cut-fish.	Halibut.
I.	13	46	108	41	2	2
II.	-	9	5	8	-	-
Total	13	55	113	49	2	2

	Turbot.	Brill.	Plaice.	Witch.	Lemon Dab.	Common Dab.	Flounder.
I.	6	64	1,159	327	6	205	12
II.	-	-	-	-	-	183	-
Total	6	64	1,159	327	6	388	12

In addition to those in the Table, there were 3 herrings, 34 anglers, and 18 thornbacks.

In the same locality, but in rather shallower water, another haul was taken on the 8th, which may be here referred to. The depth was from 7 to 10 fathoms, but mostly 7, 8, and 9, and it lasted four hours and twelve minutes. The catch was smaller than in the others, totalling 367 fishes, 334 being marketable and 33 unmarketable. Plaice were not so numerous, consisting of 263 (3 baskets of mediums and 1½ of small). There were also 2 turbot and 21 brill. Haddocks were represented by 3 small, unmarketable specimens, but, on the other hand, there were 17 cod.

After the three first hauls above referred to, the vessel shifted a little further out into deeper water. The light on Burghhead pier bore about S.S.E., and the depths ranged to about 25 fathoms, the distance from the light being about four miles. In the first haul, in from 17 to 20 fathoms, which lasted for four hours and ten minutes, 1295 fishes were caught, of which 1011 were marketable and 284 unmarketable. The bulk of the catch was made up of plaice, haddocks, and witches. There were 273 plaice, mostly medium and small (*see* page 35), and all marketable, 371 witches, all marketable and all except four large, while the number of haddocks was 277, of which 213 were marketable, though nearly all were small. The catch included 12 cod, 22 codling, 2 coal-fish, 2 cat-fish, 3 turbot, and 4 brill.

The second haul, made in the same locality in from about 17 to 21 fathoms, and which lasted for four hours and five minutes, yielded 1460 fishes, of which 1081 were marketable and 379 unmarketable. Haddocks were much scarcer than in the preceding drag, the bulk of the fishes being plaice and witches. The number of plaice was 384, and they were all marketable; most of them were mediums and thirds. The witches numbered 528, there being 466 large, marketable, and 62 unmarketable. There were also 11 brill, 1 turbot, 6 lemon dabs, 10 cod, and 2 cat-fish. The number of haddocks was 148, and 63 of them were too small to be marketable. It is of interest to note that in this catch there were 9 berried edible crabs.

The next haul in the same place, for four hours and fifteen minutes, yielded 1013 fishes, 822 being marketable and 191 unmarketable. Plaice were the most numerous in the catch, the total being 563, and all but 11 marketable. Witches were much less abundant, the total being 74, 4 of them unmarketable. Among the other flat-fishes were 1 halibut, 4 turbot, and 18 brill, as well as a black or common sole—a fish which is exceedingly scarce in the Moray Firth. Haddocks were scarce, only 64 being taken, nearly all small, and 18 unmarketable. The number of cod was 5, and there were 2 cat-fish, 1 starry ray, and 4 cuckoo rays. In the next haul, which lasted for four hours and fifteen minutes, the range of depth was rather greater, from 12 to 25 fathoms. The aggregate number of fishes was 707, of which 599 were marketable and 108 unmarketable. Plaice formed the bulk of the catch, numbering 385, and all but 4 were marketable. There were 60 witches, 3 of which were unmarketable, 3 turbot, 14 brill, and 1 megrim. Haddocks were poorly represented, the number being 67, and 7 were unmarketable and nearly all the others small. Three cod and 27 codling were taken, 7 of these being unmarketable, as well as 2 coal-fish and a cat-fish. A fifth haul, lasting for four hours and ten minutes, in somewhat shallower water, from 13 to 17 fathoms, yielded a total of 816 fishes, 673 being marketable and 143 unmarketable. The result was much the same as in the previous four drags, the bulk of the catch consisting of plaice, which numbered 456, all but 6 being marketable. There were 65 witches, all marketable, 1 turbot, 14 brill, 5 cod, and a cat-fish.

Altogether, in the five hauls off Burghead, the aggregate time of actual fishing being twenty hours and fifty-five minutes, the total number of fishes taken was 5291, of which 4186 were marketable and 1105 unmarketable. The particulars for each kind of fish are given in the following Table, the marketable being shown on the first line (I.) and the unmarketable on the second line (II.).

	Cod.	Codling.	Haddock.	Whiting.	Coal-fish.	Cat-fish.	Halibut.	Turbot.
I.	35	52	425	105	4	8	1	12
II.	-	15	158	37	-	-	-	-
Total	35	67	583	142	4	8	1	12

	Brill.	Plaice.	Witch.	Lemon Dab.	Common Dab.	Megrim.	Flounder.
I.	61	2,040	1,029	15	258	1	10
II.	-	21	69	-	678	-	1
Total	61	2,061	1,098	15	936	1	11

	Long Rough Dab.	Sole.	Herring.	Thorn-back.	Starry Ray.	Cuckoo Ray.	Angler.
I.	-	1	14	77	1	1	36
II.	72	-	-	14	-	3	37
Total	72	1	14	91	1	4	73

The vessel then steamed in the direction of the Cromarty Firth and made a number of hauls off the Suters of Cromarty. The distance from the Suters was about five miles to the east, and the depth varied from about 18 to 35 fathoms. The first drag, on the 9th February, lasted for 3½ hours, the depths taken being 25, 18, and 35 fathoms. The number of fishes caught was 1357, of which 1113 were marketable and 244 unmarketable. In this haul plaice were barely represented, the total being 13, and it is noteworthy that 4 were small (thirds), 7 were mediums, and 2 large; there were none belonging to the fourth class. The bulk of the catch consisted of witches, of which there were 9 basketfuls, the number being 850, and of these 792 were marketable and 58 too small to be taken to market. Among the other flat-fishes were 1 turbot, 4 lemon dabs, 224 common dabs, and 23 long rough dabs; but, in contrast to the hauls off Burghead, no brill were taken. Among the round-fishes, haddocks were much better represented, and the medium-sized fish, practically absent off Burghead Bay, were fairly represented. The total number of haddocks was 132, all but 13 being marketable; 8 were large, 58 medium, and 53 small (thirds). The number of cod caught was 16, and there were 6 marketable codlings and 1 coal-fish.

The depths got in the next haul in the same locality, which lasted for three hours and thirty-five minutes, were 23 and 29 fathoms. The number of fishes taken was 1774, of which 1411 were marketable and 363 unmarketable. The catch differed from the previous one in that plaice and haddocks were much more abundant and witches less abundant. The number of plaice taken was 278, three of them being too small to be marketable; of the marketable, 4 were large, 129 medium, 99 were thirds, and 43 fourths. The witches numbered 493, of which 477 were marketable, and the great majority were large. Among other flat-fishes were 3 brill, 2 lemon dabs, 242 common dabs, and 119 long rough dabs. The number of haddocks taken was 536, of which 483 were of marketable size, and 53 too small to be taken to market. The catch also included 27 cod, 11 codling, all but 1 marketable, as well as 26 whiting, 1 coal-fish, 1 pollack, and 2 hake. Two other hauls were taken on the 10th, the depths ascertained in the first being 12, 25, and 28 fathoms; this haul lasted for three hours and fifteen minutes. The catch consisted of 1080 fishes, 963 being marketable and 117 unmarketable. Plaice and haddocks were best represented. The former numbered 326, all marketable, there being 4 large, 150 medium, 115 thirds, and 57 fourths. There were 438 haddocks, 419 of which were marketable, and they almost entirely consisted of mediums. Witches numbered 197, all but 7 being marketable; and the catch included 5 cod, 1 hake, 2 brill, and 38 long rough dabs. The fourth drag, also on the 10th, lasted for four hours and fifteen minutes, the depths being 15, 18, and 25 fathoms. The catch amounted to 947 fishes, 831 being marketable and 116 unmarketable. There were 461 witches, all marketable and mostly large; 17 plaice, all marketable and consisting of large and mediums; 1 megrim was also taken, as well as a number of dabs. Among the round-fishes were 312 haddocks, of which 281 were marketable, 279 of them being mediums, and 2 large. There were 14 cod, 10 codlings, a hake, and a gurnard.

Altogether, in the four drags taken in the deepish water to the east of the Suters of Cromarty, the actual duration of trawling being fourteen hours and thirty-five minutes, the aggregate number of fishes caught was 5158, of which 4318 were marketable and 840 were unmarketable. The particulars as to the different fishes are shown in the following Table, the marketable being distinguished from the unmarketable.

	Cod.	Cod- ling.	Had- dock.	Whit- ing.	Coar- fish.	Pol- lack.	Hake.	Gur- nard.	Turbot.	Brill.	Plaice.
I.	62	22	1,302	55	2	1	4	-	1	5	631
II.	-	5	116	11	-	-	-	6	-	-	3
Total	62	27	1,418	66	2	1	4	6	1	5	634

	Lemon Dab.	Com. Dab.	Witch.	Megrim.	Long Rough Dab.	Floun- der.	Her- ring.	Angler.	Thorn- back.	Grey Skate.
I.	6	177	1,920	1	-	2	2	29	76	20
II.	-	384	81	-	197	-	-	22	15	-
Total	6	561	2,001	1	197	2	2	51	91	20

The vessel then proceeded to the Dornoch Firth, where some hauls were taken, but the catches were not as a rule very large. The first was made on the 9th February, mostly in 10 and 12 fathoms, and it lasted for four hours and a half. The number of fishes caught was 1195, of which 942 were marketable and 253 unmarketable. Plaice were most numerously represented, the number being 805, of which 740 were marketable and 65 unmarketable; the former consisted of 2 large, 106 mediums, 260 thirds, and 372 fourths. The other flat-fishes included 1 brill, 4 lemon dabs, 199 common dabs, and 166 flounders. Round-fishes were practically absent, being represented only by 2 small haddocks. The next haul was for an hour, with the small-meshed net around the cod-end of the otter-trawl. In the latter the number of fishes amounted to 277, of which 138 were marketable. The plaice numbered 240, of which 115 were marketable and 125 too small to be marketable. There were also 18 flounders and 9 small common dabs. Round-fishes again were represented by only 2 small, unmarketable haddocks. The third drag in the Dornoch Firth, in from about  $4\frac{1}{2}$  to 12 fathoms, lasted for four hours and ten minutes, and the number of fishes taken was 950, the number marketable being 624 and the unmarketable 326. The catch included 788 plaice, most of them being small; 312 were too small to be marketable, and of the 476 marketable, 254 belonged to the fourth class, 143 to the third, and 79 to the second (mediums). Among the flat-fishes were also no less than 140 flounders, while the common dabs numbered 8. Haddocks were represented by a single unmarketable specimen, and there were no other round-fishes.

Omitting the haul with the small-meshed net around the cod-end of the otter-trawl, the total number of fishes taken in the two ordinary hauls, representing eight hours and forty minutes' trawling, was 2145, of which 1566 were marketable and 579 unmarketable. The particulars in regard to the different species of fish, marketable and unmarketable, are as follows:—

	Haddock.	Brill.	Plaice.	Lemon Dab.	Common Dab.	Flounder.	Angler.	Thorn- back.
I.	2	1	1,216	4	17	306	-	20
II.	1	-	377	-	190	-	3	8
Total	3	1	1,593	4	207	306	3	28

The numbers of the different kinds taken in the small-meshed net may be contrasted with the numbers taken in the trawl net.

	In Otter-trawl.	In Small-meshed Net outside Trawl Net.
Haddock, . . . . .	2	1
Whiting, . . . . .	—	628
Codling, . . . . .	—	7
Gurnard, . . . . .	—	8
Plaice, . . . . .	240	355
Common Dab, . . . . .	9	524
Long Rough Dab, . . . . .	—	6
Small or Yellow Sole, . . . . .	—	6
Herring, . . . . .	—	8
Sprat, . . . . .	—	15
Armed Bullhead, . . . . .	—	6
Goby, sp., . . . . .	—	3
Sand-eel, . . . . .	—	3
Pipe-fish, . . . . .	—	6
Flounder, . . . . .	18	—
Angler, . . . . .	3	—
Thornback, . . . . .	5	—
	<hr/> 277	<hr/> 1576

In the hour's drag a total of at least 1853 fishes had entered the trawl, of which it retained 277, while the remaining 1576 escaped through the meshes of the trawl and were retained by the small-meshed net. The result shows that haddocks, both big and little, were practically absent from the grounds in the Dornoch Firth which were fished over at the time; that small whittings, too small to be taken in the otter-trawl, were present in large numbers, while large whittings were absent, and that small codling were there in inconsiderable numbers. No codling or whiting were caught in any of the hauls with the ordinary net. The large number of small plaice which escaped from the trawl net is also noteworthy, and still more, the common dabs. On the other hand, while 18 flounders were taken in the otter-trawl, none were got in the small-meshed net, the smaller flounders not making their way into water of 6½ fathoms depth, but remaining close in on the beach and the brackish water. The abundance of large flounders in the deepish water at this time of year is in agreement with what has been found on other occasions,\* and is referred to more fully below. The presence of young gurnards may be noted.

After leaving the Dornoch Firth, the grounds east of the Sutors of Cromarty were again visited, as above stated, and an attempt was then made to go to Smith Bank, but owing to the strong wind and high sea the vessel was forced to turn, and it then proceeded to Aberdeen Bay. Here a haul was made off the Quarries, on February 11th, in from eight to twelve fathoms of water; it lasted for an hour, the small-meshed net being attached as described above. There was a strong north-west breeze and a rough sea, and the number of fishes taken in the otter-trawl was only 60, 47 being marketable and 13 unmarketable. The catch consisted of 7 cod, 20 codlings, all marketable, 14 marketable haddocks, and 3 whittings among the round-fishes, while the flat-fishes were represented by only 7 common dabs, no plaice being taken, and there were also 9 starry nys.

\* *Twenty-first Annual Report, Part III., p. 44.*

A second haul, for three hours and forty minutes, in from 10 to 12 fathoms, was made in the same locality, the number of fishes secured being 252, an extremely poor catch. The marketable numbered 162 and the unmarketable 90. Round-fishes were again most numerous; there were 5 cod, 35 codling, all but 3 marketable, 146 haddocks, of which 121 were marketable, 12 unmarketable whittings, and 6 gurnards. Flat-fishes were scarce, and consisted of 3 medium-sized plaice, a single flounder, and 12 common dabs.

The fish contained in the small-meshed net numbered 490, and belonged to eleven species. The particulars for each of the nets are as follows:—

	Otter-trawl.	Small-meshed Net.
Cod, . . . . .	7	—
Codling, . . . . .	20	16
Haddock, . . . . .	14	—
Whiting, . . . . .	3	150
Gurnard, . . . . .	—	2
Lesser Weaver, . . . . .	—	1
Goby, sp., . . . . .	—	4
Armed Bullhead, . . . . .	—	2
Plaice, . . . . .	—	2
Common Dab, . . . . .	7	18
Herring, . . . . .	—	3
Sprat, . . . . .	—	291
Pipe-fish, . . . . .	—	1
Starry Ray, . . . . .	9	—
	60	490

The quantity of fish landed at the market by the vessel as a result of this trip was as follows, the particulars having been supplied by the Fishery Officer; the total weight being 151½ cwts. :—

Cod.	Codling.	Coal-fish.	Haddock.	Whiting.	Cnt-fish.	Angler.	Hake.	Turbot.
24½	3½	1½	12½	1½	3	5	½	½
Halibut.	Lemon Dab.	Plaice.	Brill.	Common Dab.	Witch.	Flounder.	Skate.	
½	½	52½	2½	3½	28½	4	8	

#### REMARKS ON THE MATURITY OF THE FISHES.

During the investigations carried on in February a number of observations were made by Dr. Williamson, who had been requested to determine in as many cases as possible the condition of sexual maturity of the fishes, especially by using pressure in the ordinary way to see whether ripe eggs or spermatc fluid could be squeezed out, or to note whether the fish were spawning. In the hauls made at Burghhead Bay between the 7th and 9th February, 2 of the male cod taken were found to be quite ripe, but none of the females appeared to be ripe; the number of cod caught was over 60. The ripe males were obtained about four miles off, in from 18 to 30 fathoms of water. Of 4 coal-fishes captured in these hauls, 3 were males and 1 was a female; the 3 males were ripe and "running" and the female was ripe and had transparent eggs.

Some of the plaice which were taken were also found to be ripe, though the great majority were immature. The number measured and examined by Dr. Williamson at Burghhead Bay was 1534, and of these, so far as could be observed, 3 males and 5 females were ripe, 4 of the females being

in reality spent, but a few mature eggs could still be squeezed from them. The sizes of these were as follows :—Males, 392, 420, 440 mm. ; females, 520, 530, 595, 625, 685 mm. These fishes were got in from 12 to 25 fathoms. Besides these, 3 males and 43 females were nearly ripe, the sizes of which were as follows, in millimetres :—

Males—395, 415, 436 mm.

Females—386, 388, 391, 392, 393, 400, 400, 403, 409, 412, 412, 415, 419, 420, 420, 420, 420, 431, 435, 440, 443, 445, 456, 457, 460, 460, 461, 470, 476, 481, 488, 501, 505, 508, 510, 530, 550, 564, 595, 634, 655, 674.

The smallest of the females indicated as immature measured 21·8 cm., and the largest 46 cm. ; the smallest of the males was 20·5 cm., and the largest 43 cm.

Four nearly ripe female plaice were also obtained in one of the hauls in from 23 to 29 fathoms, five miles off the Sutors of Cromarty. Their sizes were as follows :—498, 511, 561, 704 mm.

In the previous year, at the very end of March (30th and 31st), a few spawning and spent plaice were taken at the outer part of Dornoch Firth, but they were not numerous.\*

In a previous year at the latter part of January and in the middle of February, spawning plaice were got in large numbers on Smith Bank and a little to the south of it.†

Only one ripe haddock was found ; it was a male, one of 62 large specimens caught in 23-29 fathoms, five miles east of the Sutors of Cromarty, on 7th February. Haddocks, however, and especially large haddocks, were very scarce during the trip.

Flounders, which were taken in large numbers, were not as a rule quite ripe. Ripe males were obtained a few miles off Burghead in from 17 to 25 fathoms, and ripe males and females were taken in the Dornoch Firth. Most of the females were full and nearly ripe, but not spawning. As previously stated, flounders migrate to the deeper waters offshore in spring, for the purpose of spawning, and are then caught in the trawl in considerable numbers. A large one was caught in from 23 to 29 fathoms, about 5 miles off the Sutors of Cromarty. In the Dornoch Firth as many as 140 and 166 were taken in single hauls.

None of the turbot or brill taken were ripe. The number of these fishes got at Burghead Bay was large, viz., in the nine hauls 146 brill and 21 turbot. Five brill and a turbot were also secured in the deeper water off the Sutors of Cromarty. In one of the hauls off Burghead, 37 brill were captured, in another 21, and in a third 18. All the specimens of both species were large enough to be marketable, which is the usual experience ; and their abundance was no doubt associated with the presence of herrings on the ground.

## II.

At the end of March a series of trawlings was made in Aberdeen Bay by the steam-trawler "Fifeness," from the morning of the 27th to the morning of the 29th. Fish were remarkably scarce, with the exception of cod and codling, of which a considerable number were taken. Haddocks were practically absent from the grounds, only a few being got. The wind during the continuance of the work was from the south-east at first, and later from the south-west, and it was a moderate breeze. The first ordinary haul was taken in from 6 to 10 fathoms, between Donmouth

\* *Twenty-third Annual Report, Part III.*, p. 21.

† *Seventh Annual Report, Part III.*, p. 171.

and "Black Dog," and it lasted for three hours and five minutes. The total number of fishes caught was 232, consisting of 208 marketable and 24 unmarketable. Among the former were 50 cod, of a rather small size, known as "half-cod," as well as 46 codling, 100 plaice, all but 2 marketable and of medium size, 5 flounders, a common dab, and 30 starry rays. The second haul, for four hours and ten minutes, off Newburgh, in 6 to 12 fathoms, yielded only 158 fishes, the marketable numbering 135. They consisted of 29 cod, 38 codling, 23 plaice, and a few others, including 62 starry rays. The third haul, a little further to the north, in about the same depths, for three hours and fifty minutes, yielded 297 fishes, of which 292 were marketable. Cod were less numerous, numbering 4; there were also 9 codling, a few dabs and starry rays, and a lumpsucker, while on this occasion the catch of plaice was relatively large, viz., 258, most of them being medium, and 9 large. The numbers in other hauls were even less.

Altogether, in six recorded hauls, representing twenty hours and thirty-five minutes of actual trawling, the total number of fishes taken was only 1018, consisting of 937 marketable and 81 unmarketable. The particulars are as follows, the marketable being indicated on the first line:—

	Cod.	Codling.	Had-dock.	Whiting.	Plaice.	Flounder.	Com. Dab.	Starry Ray.
I.	90	119	3	10	567	9	55	84
II.	-	1	-	7	2	1	21	49
Total	90	120	3	17	569	10	76	133

Two hauls were made with the small-meshed net around the cod-end, the first in from 6 to 10 fathoms between Donmouth and "Black Dog," and it lasted for one hour and five minutes. The number of fishes in the otter trawl was only 30, consisting of 21 codling, 2 plaice, 2 whiting, and 5 starry rays. In the small-meshed net outside the cod-end were 154 small dabs measuring from 29 mm. ( $1\frac{1}{8}$  inches) to 177 mm. (3 inches), as shown on page 252.

The second haul was taken in deeper water, about 3 miles off Girdleness, the depth being from 18 to 25 fathoms, and it lasted for seventy minutes. In the otter trawl, which was torn, there were 76 fishes, and in the small-meshed net 718, as follows:—

	In Trawl.	In Small-meshed Net.
Codling, . . . . .	9	6
Ling, . . . . .	3	—
Haddock, . . . . .	19	314
Whiting, . . . . .	3	364
Norway Pout, . . . . .	—	9
Turbot, . . . . .	1	—
Plaice, . . . . .	14	—
Lemon Dab, . . . . .	6	—
Common Dab, . . . . .	21	5
Long Rough Dab, . . . . .	—	16
Herring, . . . . .	—	4
	<hr/> 76	<hr/> 718



The quantity of fish, as returned by the officer, which was landed at the market, as the result of twelve hauls and forty-one hours and fifty-five minutes actual trawling, was 47 cwts., as follows :—

Cod.	Codling.	Ling.	Turbot.	Halibut.	Lemon Dab.	Plaice.	Dabs.	Skate.
17½	8	½	½	½	½	16½	2	2

### III.

The next series of trawlings was made by the steam trawler "Star of the Ocean" in the Moray Firth at the end of September and the beginning of October, and the trip was not a very productive one. Fairly good catches of plaice were obtained in the Dornoch Firth and at Burghead Bay, but they were mostly small, and marketable haddocks were scarce. On the other hand, small haddocks, too small to be marketable, were very abundant, and the same was the case with small unmarketable plaice.

The first place visited was Burghead Bay, where a haul was taken on 28th September for two hours and five minutes, in from 5 to 12 fathoms of water. The number of fishes caught was 2470, of which 803 were marketable and 1667 unmarketable. Haddocks and plaice were most abundant. The number of haddocks taken was 1423, but only 73, which were of medium size, were marketable, the other 1350 being too small for market. Of a total of 738 plaice, all but 16 were marketable, but by far the greater proportion were small, viz., 711. Among the other flat-fishes were 2 brill, a lemon dab, and 208 common dabs.

The vessel then steamed to the Dornoch Firth, where a number of hauls were made off Dunrobin Castle. The first, in from 5 to 15 fathoms, lasted for four hours and five minutes, the total number of fishes taken being 2909. Most of them were unmarketable, viz., 1994, while the other 915 were marketable. The catch consisted mostly of plaice and small haddocks. The plaice numbered 2095, of which 828 were marketable and 1267 unmarketable. The former consisted of 23 large, 30 medium, and 775 small. Among the flat-fishes were fourteen lemon dabs and 1 witch. All the haddocks taken, 549 in number, were too small to be marketable; all the 52 whittings caught were also unmarketable. The catch included 19 cod, 57 codling, 11 of which were unmarketable, 51 gurnards, and a number of dabs. The next drag, which was for four hours in much the same depth of water, yielded 814 marketable and 630 unmarketable fishes, a total of 1444. The haddocks numbered 424, all but 24 being unmarketable. There were 967 plaice, of which 215 were unmarketable, and 12 lemon dabs. Rather an unusual feature was the presence of 19 mackerel among the other fishes. It is not very uncommon for an odd mackerel to be taken in the course of these trawlings, but rarely so many are captured. The next haul, in from about 6½ to 15 fathoms, and which lasted two hours and fifty-five minutes, yielded the large total of 4833 fishes, 1172 being marketable and 3661 unmarketable. Haddocks were very numerous, the total being 2291, but only 36 of these were marketable; all the rest were thrown overboard. The only other round-fishes present were 3 codling, 1 whiting, and 63 gurnards. Plaice were even more numerous than the haddocks, the total number being 2465, and 1123 of them were marketable and 1342 unmarketable; of the former 7 were large, 86 medium, and 1030 small. A mackerel was taken in this catch and also five lemon dabs.

In the next drag, in from 6 to 15 fathoms, which lasted four hours and five minutes, the large total of 6447 fishes were caught, 1559 being marketable and no less than 4888 unmarketable. Plaice were most

numerous, the total number being 3908, of which 1430 were marketable and 2478 unmarketable; the former included 2 large, 100 medium, and 1328 small. The number of haddocks taken was 1888, of which 122 were marketable and 1766 unmarketable. Five codling, 2 lemon dabs, and a number of common dabs and gurnards were comprised in the catch.

The succeeding two drags were also exceedingly productive as far as the number of fishes was concerned. In one, made in from 8 to 15 fathoms, and lasting for four hours and twenty-five minutes, the total catch amounted to 5991, of which 916 were marketable and 5075 unmarketable. The latter filled nearly twenty baskets. The number of plaice caught was 1623, 754 being marketable and 869 unmarketable—the great proportion of the former being small, as in the previous drags. Of 4091 haddocks, only 141 were of marketable size, 100 of them being large and 41 medium. The other 3950 were thrown away. Eleven codling were taken in this haul, as well as a turbot, 6 lemon dabs, and a number of unmarketable common dabs. The next haul, in the same locality for four hours and fifteen minutes, yielded 3939 fishes, of which 1378 were marketable and 2561 unmarketable. The plaice numbered 3552, the marketable aggregating 1273 and the unmarketable 1279. The other flat-fishes were 11 lemon dabs and 67 common dabs. The haddocks numbered 1118, of which 71 were marketable and 1047 unmarketable. Three mackerel were taken in this drag.

Altogether, in the six recorded hauls in the Dornoch Firth, the duration of actual trawling being 23 hours and 45 minutes, the aggregate number of fishes taken was 25,563, of which 6754 were marketable and 18,809 unmarketable, the percentage of the former being 26·5 and of the latter 73·5. The proportion of the unmarketable fishes was thus very large and far above what is usual. In the February hauls the proportion was almost exactly reversed, there being then 73 per cent. of the total catch marketable and 27 per cent. unmarketable. The particulars of the marketable and unmarketable of each kind of fish are as follows:—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Plaice.	Turbot.
I.	19	77	394	1	-	6,160	1
II.	-	12	9,967	52	458	7,450	-
Total	19	89	10,361	53	458	13,610	1
	Common Dab.	Lemon Dab.	Witch.	Long Rough Dab.	Mackerel.	Angler.	Thorn-back.
I.	7	50	1	-	23	-	21
II.	828	-	-	23	-	16	3
Total	835	50	1	23	23	16	24

From this it will be seen that the total number of haddocks caught in the six hauls was 10,361, and of these 9967, or 96 per cent., were unmarketable, while the total number of plaice taken was 13,610, of which 7450, or 54 per cent., were unmarketable. The difference between

the February and September hauls in regard to the numbers of small unmarketable fishes may be contrasted by comparing the numbers taken per hour's fishing, as follows :—

	Marketable.	Unmarketable.	Total.
February	181	67	248
September	284·4	791·9	1076·3

The proportion of small plaice and especially small haddocks, differed very much, as the following figures of the numbers taken on each occasion per hour's fishing show.

	HADDOCK.			PLAICE.		
	Market-able.	Unmarket-able.	Total.	Market-able.	Unmarket-able.	Total.
February, -	0·23	0·11	0·34	140·4	43·5	184
September, -	16·6	419·6	436·2	259·3	313·7	573

The circumstances show to what an extent the capture of immature specimens of these fishes may take place at some seasons in bays by the use of the trawl-net. All the young haddocks taken in this way probably perish, and there is no doubt that the great majority of the young plaice perish likewise, although, apart from previous experiments recorded on the point, there are reasons for supposing that under favourable conditions a considerable number may survive. Thus, in February, Dr. Williamson observed that some of the small plaice which had been lying all night in a basket along with a number of other small fish taken in the small-meshed net were alive at 10.30 next morning. When placed in a bucket of sea water they swam about freely.

After leaving the Dornoch Firth, a haul, which lasted two hours and twenty minutes, was made outside the entrance to Cromarty Firth, the depth being about twelve fathoms. The catch was a small one, consisting of 479 fishes, of which 182 were marketable and 297 unmarketable. Haddocks were present in greatest abundance, 395 being taken, of which 141 were marketable and 254 unmarketable. The other round-fishes comprised 2 cod, 7 codling, 2 small whiting, and 4 gurnards. The number of plaice was 61, of which 35 were marketable and 26 unmarketable; the only other flat-fish represented was the common dab, of which there were 6.

Burghead Bay was then visited and a number of hauls taken in depths ranging from about 5 to 15 fathoms. In the first, in from 5 to 12 fathoms, which lasted for four hours and thirty-five minutes, 3901 fishes were secured, 1479 being marketable and 2422 unmarketable. Plaice and haddocks formed the bulk of the catch. Of the former the number obtained was 1460, of which 1194 were marketable and 266 unmarketable—a proportion contrasting with the condition in the Dornoch Firth. Small haddocks were, however, very numerous, for of a total of 1334 haddocks caught only 29 were marketable, the remaining 1305 being too small to be taken to market. The catch included among round-fishes 1

cod, 7 codling, 13 whiting, and 159 gurnards, and the other flat-fishes were 9 brill, 10 lemon dabs, 7 witches, and 866 common dabs. The next haul, for four hours and five minutes, in from 8 to 12 fathoms, was less productive, the total number of fishes taken being 791, of which 591 were marketable and 200 unmarketable. No marketable haddocks were obtained, and only 56 unmarketable. There were 7 brill, 4 lemon dabs, 120 common dabs, and 559 plaice, of which 535 were marketable and 24 unmarketable.

Several other drags were made in the same locality, in some of which the net was badly torn and the catches were small. The particulars in regard to three of them, in which this did not occur, are as follows. In the first, in from 8 to 14 fathoms, and which lasted for four hours and twenty minutes, the number of fishes secured was 2218, those marketable numbering 1162, and the unmarketable 1056. The most abundant of the fishes was plaice, which totalled 1220, of which 1012 were marketable and 208 unmarketable. Common dabs were also numerous, the total being 622, but 492 of them were unmarketable. Other flat-fishes included 1 turbot, 12 brill, and a lemon dab. The total of haddocks was 101, only 5 being marketable; there were also 9 codling and 216 gurnards. The next haul, which lasted for four hours and fifteen minutes, and was made in water of from 8 to 13 fathoms depth, yielded 1569 fishes, 854 being marketable and 715 unmarketable. Plaice, common dabs, and haddocks formed the bulk of the catch. The plaice numbered 792, of which 690 were marketable and 102 unmarketable. Three brill and a black or common sole were also taken, as well as 268 common dabs, 14 witches, and 5 lemon dabs. In the third of the hauls, lasting for four hours and a half, and in the same depths, 1898 fishes were obtained, 931 being marketable and 967 unmarketable. The plaice numbered 919, of which 826 were marketable and 93 unmarketable. There were 416 small haddocks, all being unmarketable. Other round-fishes included 6 codling, 103 whiting, and 38 gurnard. There were also 398 common dabs and 3 lemon dabs.

In the five drags collectively, the time of trawling occupying 21 hours and 45 minutes, the total number of fishes taken was 10,377, the marketable numbering 5017, or rather over half the aggregate number. The particulars of the marketable and unmarketable of the various kinds are given in the following table:—

	Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Turbot.	Brill.	Plaice.
I.	1	4	62	13	-	1	31	4,257
II.	-	36	2,198	164	468	-	-	693
Total	1	40	2,260	177	468	1	31	4,950

	Lemon Dab.	Witch.	Common Dab.	Sole.	Long Rough Dab.	Angler.	Thorn-back.
I.	23	17	585	1	-	5	17
II.	-	4	1,689	-	50	50	8
Total	23	21	2,274	1	50	55	25

The average numbers per hour's trawling of the total fishes, the marketable and unmarketable, and of the plaice and haddocks are as follows :—

	Marketable.	Unmarketable.	Total.
All kinds, . . .	230·7	246·4	477·0
Plaice, . . .	195·7	31·8	227·6
Haddock, . . .	2·9	101·0	103·9

They furnish a strong contrast to the corresponding figures for the Dornoch Firth.

The quantity of fishes, in cwts., landed at the market as the result of this trip is given in the following Table, the total amounting to 123½ cwts :—

Cod.	Codling.	Haddock.	Turbot.	Halibut.	Lemon Dab.	Plaice.
3½	2	5	½	½	1	99
	Brill.	Common Dab.	Witch.	Skates.		
	1½	5½	½	6		

Of the plaice, there were 5½ cwts. of large, 25½ cwts. of medium, and 68 cwts. of small.

#### IV.

At the beginning of November another series of hauls was made in the Moray Firth, mostly at Burghead Bay and in the Dornoch Firth, but also on the Caithness coast. The weather was rather stormy, and the vessel, the ' Cairntoul,' had to be run for shelter to the Cromarty Firth. The fishing turned out to be poor from the market point of view, haddocks especially, which usually form an important item in the catch, being extremely scarce.

The first haul at Burghead Bay, in from 8 to 10 fathoms of water, was for three hours and five minutes, and the total number of fishes taken was large, viz., 4331. They consisted, however, mostly of unmarketable fish, the marketable numbering 780 and the unmarketable 3551. Plaice was by far the most important, the total being 1005, of which 679 were marketable and 326 too small for market. One turbot and 7 brill were among the flat-fishes, as well as a few common dabs. A feature of the catch was the large numbers of small unmarketable haddocks that were taken. They totalled 2852, whereas not a single haddock of marketable size was taken. There were also 23 unmarketable codling, 90 whittings, and 117 gurnards. In the next haul, in the same locality, the depth being from 8 to 13 fathoms and the duration of the haul three hours and fifteen minutes, 3859 fishes were secured, of which 324 were marketable and 3535 unmarketable. The former were made up entirely of plaice, with a few dabs and two thornbacks; the plaice numbered altogether 445, of which 301 were marketable. All the round-fishes were unmarketable, and they comprised 2748 haddocks, 198 whiting, 47 codling, and 204 gurnards.

The total number of fishes taken in the two drags, the time of actual trawling being six hours and twenty minutes, was 8190, of which 1104 were marketable and 7086 unmarketable. The particulars are as follows :—

	Codling.	Haddock.	Whiting.	Gurnard.	Turbot.
I.	-	-	-	-	1
II.	70	5,600	288	321	-
Total	70	5,600	288	321	1

[Continued.]

	Brill.	Plaice.	Common Dab.	Long Rough Dab.	Thornback.
I.	7	980	107	-	9
II.	-	470	330	7	-
Total	7	1,450	437	7	9

The steamer then went to the Dornoch Firth, where some hauls were taken on the usual ground. The catches here contrasted with those at Burghead Bay in that round-fishes of marketable sizes were present, though not in great numbers, but the small haddocks were still abundant. The first drag, in 8 to 13 fathoms, which lasted for three hours and ten minutes, yielded 2557 fishes, of which 188 were marketable and 2369 were unmarketable. There were 7 cod and 12 codling, all marketable, and the haddocks numbered 2358, consisting of 88 which were marketable and 2270 which were unmarketable. There were also 14 marketable whiting, 1 coalfish, and 27 gurnards. The plaice numbered only 69, 51 of which were marketable, and the other flat-fishes comprised 14 lemon dabs and 55 common dabs.

The next haul, in from 6 to 10 fathoms, which lasted for three hours and twenty minutes, yielded 1013 fishes, consisting of 227 marketable and 786 unmarketable. The catch included 2 cod, 29 codling, 11 of them marketable, 118 whiting, mostly small, and 14 gurnards. The haddocks numbered 641, of which 59 were marketable and 582 unmarketable. The plaice comprised 143 marketable specimens and 39 unmarketable, and there were a few common dabs.

In the two drags made in the Dornoch Firth and completely recorded, the actual time of trawling being six hours and a half, the aggregate catch was 3570 fishes, of which 415 were marketable and 3155 unmarketable. The particulars as to the marketable and unmarketable of the different species are as follows :—

	Cod.	Codling.	Haddock.	Whiting.	Coal-fish.
I.	9	23	147	26	1
II.	-	18	2,852	106	-
Total	9	41	2,999	132	1

	Gurnard.	Plaice.	Lemon Dab.	Common Dab.	Angler.
I.	-	194	6	9	-
II.	41	57	8	72	1
Total	41	251	14	81	1

On leaving the Dornoch Firth the vessel steamed up the coast and took some hauls off Lybster and Noss Head; the weather was bad and the catches poor, though a number of cod were obtained. In a haul for three hours and twenty minutes off Lybster, in from about 18 to 30 fathoms, the total number of fishes caught was 356, of which 110 were marketable. There were 40 cod and 63 codling, all, except one, of marketable size, but haddocks were scarce, only 28 being taken, and all of

them unmarketable; there were also 13 unmarketable whittings, 10 plaice, and 202 gurnards. The catch off Noss Head was not completely recorded, but it included a number of cod and codling, and three baskets of gurnards.

The weather at this time was very bad, a strong wind blowing from the south-east, and the sea was high. The vessel left the Caithness coast and steamed to Burghead Bay, where some more hauls were taken. Fairly good catches of plaice were got, but marketable round-fishes were practically absent, while the small unmarketable haddocks were much less abundant than on the previous visit a few days before. The first drag, in from about 6 to 10 fathoms, lasted for four hours and five minutes, the catch numbering 1026 fishes, of which 541 were marketable and 485 unmarketable. The marketable fishes were confined to flat-fishes, viz., 2 brill, 535 plaice, and 4 common dabs; there were also 21 unmarketable plaice and 71 unmarketable dabs. There were 332 small haddocks, 22 small whittings, and 36 gurnards, all unmarketable.

The number of fishes taken in the second haul, in from about 5 to 9 fathoms, and which lasted for four hours and five minutes, was 1858, the marketable amounting to 1037 and the unmarketable to 821. Among the round-fishes were 1 cod, 5 small codling, 606 haddocks, all small and unmarketable, 52 unmarketable whiting, and 19 gurnards. The flat fishes comprised 3 turbot, 2 brill, 1046 plaice, of which 1015 were marketable, 1 witch, and 116 common dabs. In the third haul, in the same locality and depth, the number of fishes taken amounted to 1029, the haul lasting for four hours. The number marketable was 723, and there were 306 unmarketable. With the exception of one codling, all the marketable fishes consisted of flat-fishes. They comprise 4 turbot, 7 brill, 695 plaice, and 16 common dabs; there were also 38 unmarketable plaice and 115 unmarketable dabs. The round-fishes included 9 codling, 57 unmarketable haddocks, 15 whiting, and 71 gurnards.

Altogether in these three recorded hauls in Burghead Bay, the actual duration of the trawling operations being 12 hours and 10 minutes, the aggregate number of fishes captured was 3913, of which 2301 were marketable and 1612 unmarketable. The particulars as to the marketable and unmarketable of the various species are given in the following Table:—

Cod.	Codling.	Haddock.	Whiting.	Gurnard.	Turbot.	Brill.	Plaice.
1	1				7	11	2,245
-	13	995	89	126	-	-	90
1	14	995	89	126	7	11	2,335
Common Dab.		Witch.	Long Rough Dab.	Angler.	Thornback.		
32		1			3		
290		-	5	4	-		
322		1	5	4	3		

As a result of the week's working in the Moray Firth, during which 19 hauls were made, the total quantity of fish landed at the market by the vessel was 66½ cwts. As already stated, the weather was severe during most of the time and the steamer had to run for shelter on two occasions. The quantities of the different kinds of fish landed were as follows:—

Cod.	Codling.	Saithe.	Haddock.	Catfish.	Turbot.	Lemon Dab.
10½	3	½	1½	½	½	½
Plaice.		Brill.	Common Dab.	Witch.	Thornback.	
44½		1	1½	1½	2	

## Part III.—Twenty-fourth Annual Report

TRAWLING INVESTIGATIONS—TABLE I.

Place	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remark
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
1. Burgh- head Bay.	1905. Feb. 6.	..	..	..	5-12	3.0 p.m.	7.0 p.m.	Cod, .. ..	2	..	2	Wind W.; li
								Codling, .. ..	7	9	16	
								Haddock (1), .. ..	1	..	..	
								" (2), .. ..	..	..	..	
								" (3), .. ..	38	..	..	
								Whiting, .. ..	18	5	44	
								Cat-fish, .. ..	2	8	26	
								Halibut, .. ..	1	..	1	
								Turbot, .. ..	3	..	3	
								Brill, .. ..	13	..	13	
								Plaice (1), .. ..	1	..	..	
								" (2), .. ..	162	..	..	
								" (3), .. ..	129	..	..	
								Witch (1), .. ..	100	..	100	
								Lemon Dab, .. ..	1	..	1	
								Com. Dab, .. ..	26	48	74	
								Flounder, .. ..	7	..	7	
								Herring, .. ..	..	3	3	
								Angler, .. ..	..	12	12	
									511	85	596	
2. "	"	..	..	..	"	7.35 p.m.	11.40 p.m.	Cod, .. ..	7	..	7	Wind W. b fresh breeze
								Codling, .. ..	11	..	11	
								Haddock (1), .. ..	4	..	..	
								" (2), .. ..	..	..	..	
								" (3), .. ..	22	..	..	
								Whiting, .. ..	26	..	26	
								Halibut, .. ..	9	..	9	
								Halibut, .. ..	1	..	1	
								Turbot, .. ..	3	..	3	
								Brill, .. ..	14	..	14	
								Plaice (1), .. ..	1	..	..	
								" (2), .. ..	245	..	..	
								" (3), .. ..	178	..	..	
								" (4), .. ..	68	..	..	
								Witch (1), .. ..	49	..	49	
								Com. Dab, .. ..	100	60	160	
								Thornbacks, .. ..	..	12	12	
								Angler, .. ..	..	8	8	
									712	80	792	
3. "	Feb. 7.	45.7	41.7	44.0	"	5.0 a.m.	9.0 a.m.	Cod, .. ..	4	..	4	
								Codling, .. ..	28	..	28	
								Haddock (1), .. ..	1	..	..	
								" (3), .. ..	42	..	..	
								Whiting, .. ..	43	..	43	
								Brill, .. ..	14	..	14	
								Plaice (1), .. ..	37	..	37	
								" (2), .. ..	6	..	..	
								" (3), .. ..	154	..	..	
								" (4), .. ..	145	..	..	
								Lemon Dab, .. ..	70	..	..	
								Witch (1), .. ..	875	..	375	
								Com. Dab, .. ..	5	..	5	
								Flounder, .. ..	178	..	178	
								Thornback, .. ..	79	75	154	
								Angler, .. ..	5	..	5	
									..	6	6	
									..	14	14	
									768	95	863	



TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth In Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
Off Burghead Bay.	1905. Feb. 7.	45° 0	42° 5	43° 0	17-20	1.50 p.m.	6.0 p.m.	Cod, .. .. .	12	..	12	Burghead bearing S. S. E.
								Codling, .. .. .	22	..	22	
								Haddock (1), .. .. .	10	..	..	
								" (2), .. .. .	2	..	..	
								" (4), .. .. .	201	..	..	
								— 213	64	..	277	
								Whiting (2), .. .. .	43	2	45	
								Coal-fish, .. .. .	2	..	2	
								Cat-fish, .. .. .	2	..	2	
								Turbot, .. .. .	3	..	3	
								Brill, .. .. .	4	..	4	
								Plaice, .. .. .	273	..	273	
								Lemon Dab (1), .. .. .	2	..	..	
								" (2), .. .. .	1	..	..	
								— 3	..	..	3	
								Witch (1), .. .. .	367	..	..	
								" (2), .. .. .	4	..	..	
								— 371	..	..	371	
								Com. Dab, .. .. .	40	201	241	
								Flounder, .. .. .	3	..	3	
								Herring, .. .. .	7	..	7	
								Thornback, .. .. .	13	..	13	
								Angler, .. .. .	..	17	17	
								1,011	284	1,295		
"	"	..	..	..	17-21	6.40 p.m.	10.45 p.m.	Cod, .. .. .	10	..	10	Nine berried edible crabs were taken.
								Codling, .. .. .	..	4	4	
								Haddock (1), .. .. .	..	..	..	
								" (3), .. .. .	83	..	..	
								— 85	63	..	148	
								Whiting, .. .. .	39	17	56	
								Cat-fish, .. .. .	2	..	2	
								Turbot, .. .. .	1	..	1	
								Brill, .. .. .	11	..	11	
								Plaice (1), .. .. .	1	..	..	
								" (2), .. .. .	177	..	..	
								" (3), .. .. .	166	..	..	
								" (4), .. .. .	40	..	..	
								— 384	..	..	384	
								Lemon Dab, .. .. .	6	..	6	
								Witch (1), .. .. .	466	62	528	
								Com. Dab, .. .. .	32	193	225	
								Long Rough Dab, .. .. .	..	31	31	
								Thornback, .. .. .	23	5	28	
								Angler, .. .. .	22	4	26	
								1,081	379	1,460		
Burghead Bay.	Feb. 8.	..	..	..	17-20	4.30 a.m.	8.45 a.m.	Cod, .. .. .	5	..	5	Of the plaice there were 4 large and 4 baskets medium, 2 baskets thirds, and 1 basket fourths.
								Codling, .. .. .	5	4	9	
								Haddock (1), .. .. .	1	..	..	
								" (4), .. .. .	45	..	..	
								— 46	18	..	64	
								Whiting (2), .. .. .	5	7	12	
								Cat-fish, .. .. .	2	..	2	
								Halibut, .. .. .	1	..	1	
								Turbot, .. .. .	4	..	4	
								Brill, .. .. .	18	..	18	
								Plaice, .. .. .	552	11	563	
								Lemon Dab, .. .. .	4	..	4	
								Witch, .. .. .	70	4	74	
								Com. Dab, .. .. .	73	131	204	
								Long Rough Dab, .. .. .	..	11	11	
								Flounder, .. .. .	2	..	2	
								Black Sole, .. .. .	1	..	1	
								Herring, .. .. .	3	..	3	
								Angler, .. .. .	10	..	10	
								Thornback, .. .. .	19	2	21	
								Starry Ray, .. .. .	1	..	1	
								Cuckoo Ray, .. .. .	1	3	4	
								322	191	1,013		

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
7. Burg- head Bay.	1905. Feb. 8.	42.0	41.7	42.5	12-25	9.15 a.m.	1.30 p.m.	Cod, .. .. .	3	..	3	The plaice co- ed of 2 large of 3 baskets medium, thirds, and basket of four
								Codling, .. ..	20	7	27	
								Haddock (1), ..	5	..	..	
								" (4), .. ..	55	..	..	
								Whiting, .. ..	60	7	67	
								Coal-fish, .. ..	9	6	15	
								Cat-fish, .. ..	2	..	2	
								Turbot, .. ..	1	..	1	
								Brill, .. ..	3	..	3	
								Mcgrim (1), ..	14	..	14	
								Plaice, .. ..	1	..	1	
								Lemon Dab, ..	381	4	385	
								Witch, .. ..	2	..	2	
								Com. Dab, .. ..	87	3	90	
								Flounder, .. ..	40	60	100	
								Long Rough Dab,	5	1	6	
								Angler, .. ..	..	18	18	
								Thornback, ..	..	1	1	
									1	1	2	
									509	108	707	
8. "	"	..	..	..	7-10	1.48 p.m.	6.0 p.m.	Cod, .. ..	17	..	17	The plaice co- ed of 3 baskets mediums and of thirds.
								Codling, .. ..	3	3	6	
								Haddock, .. ..	..	2	2	
								Whiting, .. ..	1	1	2	
								Turbot, .. ..	2	..	2	
								Brill, .. ..	21	..	21	
								Plaice, .. ..	263	5	268	
								Lemon Dab, ..	2	..	2	
								Com. Dab, .. ..	16	20	36	
								Flounder, .. ..	7	..	7	
								Long Rough Dab,	..	1	1	
								Angler, .. ..	..	1	1	
								Thornback, ..	2	..	2	
									334	33	367	
9. "	"	..	..	..	13-17	6.30 p.m.	10.40 p.m.	Cod, .. ..	5	..	5	
								Codling, .. ..	5	..	5	
								Haddock (3), ..	21	6	27	
								Whiting, .. ..	9	5	14	
								Cat-fish, .. ..	1	..	1	
								Turbot, .. ..	1	..	1	
								Brill, .. ..	14	..	14	
								Plaice (2), ..	219	..	..	
								" (3), .. ..	177	..	..	
								" (4), .. ..	54	..	..	
									450	6	456	
								Witch, .. ..	65	..	65	
								Com. Dab, .. ..	73	93	160	
								Long Rough Dab,	..	12	12	
								Herring, .. ..	4	..	4	
								Angler, .. ..	4	15	19	
								Thornback, ..	21	6	27	
									673	143	816	

TRAWLING INVESTIGATIONS—TABLE I.

Loc.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
Five les east luters of marty.	1905. Feb. 9.	..	..	..	18 to 35	6.30 a.m.	10.0 a.m.	Cod, .. ..	16	..	16	There were 9 bas- kets of witches.
								Codling, .. ..	6	..	6	
								Haddock (1), ..	8	..	..	
								" (2), ..	58	..	..	
								" (3), ..	53	..	..	
								—119	..	13	132	
								Whiting, .. ..	21	..	21	
								Coal-fish, .. ..	1	..	1	
								Turbot, .. ..	1	..	1	
								Plaice (1), ..	2	..	..	
								" (2), ..	7	..	..	
								" (3), ..	4	..	..	
								—13	..	..	13	
								Lemon Dab, ..	4	..	4	
								Witch (1), ..	610	..	..	
								" (2), ..	182	..	..	
								—792	..	58	850	
								Com. Dab, ..	81	143	224	
								Long Rough Dab, ..	..	23	23	
								Angler, .. ..	7	7	14	
								Thornback, ..	33	..	33	
								Gray Skate, ..	19	..	19	
								—1113	..	244	1357	
" "	" "	" "	" "	" "	23 to 29	10.25 a.m.	2.0 p.m.	Cod, .. ..	27	..	27	
								Codling, .. ..	10	1	11	
								Haddock (1), ..	52	..	..	
								" (3), ..	431	..	..	
								—483	..	53	536	
								Whiting, .. ..	26	..	26	
								Coalfish, .. ..	1	..	1	
								Pollack, .. ..	1	..	1	
								Hake, .. ..	2	..	2	
								Gurnard, .. ..	..	3	3	
								Brill, .. ..	3	..	3	
								Plaice (1), ..	4	..	..	
								" (2), ..	129	..	..	
								" (3), ..	99	..	..	
								" (4), ..	43	..	..	
								—275	..	3	278	
								Lemon Dab, ..	2	..	2	
								Witch (1), ..	441	..	..	
								" (2), ..	36	..	..	
								—477	..	16	493	
								Com. Dab, ..	78	164	242	
								Flounder, ..	1	..	1	
								Long Rough Dab, ..	..	119	119	
								Herring, .. ..	2	..	2	
								Angler, .. ..	4	4	8	
								Thornback, ..	18	..	18	
								Grey Skate, ..	1	..	1	
								—1411	..	363	1774	
Dornoch Irish.	" "	45.1	42.5	43.0	10 to 12	4.50 p.m.	9.20 p.m.	Haddock, (3) ..	2	..	2	
								Brill, .. ..	1	..	1	
								Plaice (1), ..	2	..	..	
								" (2), ..	106	..	..	
								" (3), ..	260	..	..	
								" (4), ..	372	..	..	
								—740	..	65	805	
								Lemon Dab, ..	4	..	4	
								Com. Dab, ..	14	185	199	
								Flounder, ..	106	..	106	
								Thornback, ..	15	3	18	
								—942	..	253	1195	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
13. Dornoch Firth.	1905. Feb. 9.	..	..	..	6½ to 12	10.15 p.m.	11.15 p.m.	Haddock, .. ..	..	2	2	Small-meshed
								Plaice (2), .. ..	46	..	..	
								" (3), .. ..	53	..	..	
								" (4), .. ..	22	..	..	
								—115	125	240	..	
								Flounder, .. ..	18	..	18	
								Com. Dab, .. ..	..	9	9	
								Angler, .. ..	..	3	3	
								Thornback, .. ..	5	..	5	
								—138	139	277	..	
14. "	Feb. 10.	..	..	..	4½ to 12	5.0 a.m.	9.10 a.m.	Haddock, .. ..	..	1	1	
								Plaice (2), .. ..	59	..	..	
								" (3), .. ..	143	..	..	
								" (4), .. ..	254	..	..	
								—476	312	788	..	
								Com. Dab, .. ..	3	5	8	
								Flounder, .. ..	140	..	140	
								Angler, .. ..	..	3	3	
								Thornback, .. ..	5	..	10	
								—624	326	950	..	
15. Five miles east of the Sutors of Cromarty.	"	42.8	42.0	42.7	12 to 28	11.45 a.m.	3.0 p.m.	Cod, .. ..	5	..	5	
								Haddock (1), .. ..	7	..	..	
								" (2), .. ..	412	..	..	
								—419	19	438	..	
								Whiting, .. ..	2	2	4	
								Hake, .. ..	1	..	1	
								Gurnard, .. ..	..	2	2	
								Brill, .. ..	2	..	2	
								Plaice (1), .. ..	4	..	..	
								" (2), .. ..	150	..	..	
								" (3), .. ..	115	..	..	
								" (4), .. ..	57	..	..	
								—326	..	326	..	
								Witch, (1) .. ..	190	7	197	
								Com. Dab, .. ..	11	47	58	
								Flounder, .. ..	1	..	1	
								Long Rough Dab, .. ..	..	38	38	
								Thornback, .. ..	6	2	8	
								—963	117	1080	..	
16. "	Feb. 11.	..	..	..	15 to 25	12.30 a.m.	4.45 a.m.	Cod, .. ..	14	..	14	
								Codling, .. ..	6	4	10	
								Haddock (1), .. ..	2	..	..	
								" (2), .. ..	279	..	..	
								—281	31	312	..	
								Whiting, .. ..	6	9	15	
								Hake, .. ..	1	..	1	
								Com. Gurnard, .. ..	..	1	1	
								Plaice (1), .. ..	3	..	..	
								" (2), .. ..	14	..	..	
								—17	..	17	..	
								Witch (1), .. ..	436	..	..	
								" (2), .. ..	25	..	..	
								—461	..	461	..	
								Megrin, .. ..	1	..	1	
								Com. Dab, .. ..	7	30	37	
								Long Rough Dab, .. ..	..	17	17	
								Angler, .. ..	18	11	29	
								Thornback, .. ..	19	13	32	
								—831	116	947	..	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over-board.	Total No.	
Five miles east of the waters of Dumfries.	1905. Feb. 11.	..	..	..	..	5.20 a.m.	..	Cod, ..	1	..	1	Net badly split and catch small; Strong N.N.W. wind, increasing to a gale, with snow showers; sea very rough.
								Codling, ..	3	1	4	
								Haddock, ..	1	4	5	
								Whiting, ..	..	1	1	
								Plaice (2), ..	4	..	..	
								" (3), ..	8	..	..	
								..	12	..	12	
								Witch (1), ..	109	..	..	
								" (2), ..	9	..	..	
								..	118	..	118	
								Com. Dab, ..	..	12	12	
								Long Rough Dab, ..	..	8	8	
								Angler, ..	5	3	8	
								..	140	29	169	
Aberdeen Bay (the carries).	"	..	..	..	8 to 12	6.40 p.m.	7.40 p.m.	Cod, ..	7	..	7	Small-meshed. Strong N.W. breeze; sea rough.
								Codling, ..	20	..	20	
								Haddock (2), ..	14	..	14	
								Whiting, ..	3	..	3	
								Com. Dab, ..	3	4	7	
								Starry Ray, ..	..	9	9	
								..	47	13	60	
	"	..	..	..	12	8.20 p.m.	12.0 p.m.	Cod, ..	5	..	5	
								Codling, ..	32	3	35	
								Haddock (2), ..	121	25	146	
								Whiting, ..	..	12	12	
								Com. Gurnard, ..	..	6	6	
								Plaice (2), ..	3	..	3	
								Flounder, ..	1	..	1	
								Com. Dab, ..	..	12	12	
								Starry Ray, ..	..	32	32	
								..	162	90	252	

## Part III.—Twenty-fourth Annual Report

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
1. Aber- deen Bay between Don- mouth and Black Dog.	1905. Mar. 27.	..	53	..	6-10	6.20 a.m.	7.25 a.m.	Codling, .. Whiting, .. Plaice (2), .. Starry Ray, ..	21 .. 2 5	.. 2 .. ..	21 2 2 5	Small-meshed periment. Wind S.E.; breeze; sea r rate.
									28	2	30	
2.	..	..	..	..	..	8.0 a.m.	11.5 a.m.	Cod, .. Codling, .. Plaice (2), .. Flounder, .. Com. Dab, .. Starry Ray, ..	50 46 98 4 .. 10	.. .. 2 1 .. 20	50 46 100 5 1 30	
									208	24	232	
3. Off Newburgh.	..	..	..	..	6-12	11.55 a.m.	4.5 p.m.	Cod, .. Codling, .. Whiting, .. Plaice (2), .. Flounder, .. Com. Dab, .. Starry Ray, ..	29 38 1 23 3 1 40	.. .. 1 .. .. .. 22	29 38 2 23 3 1 62	
									135	23	158	
4. Off Newburgh and Old Castle.	..	..	..	..	5-11	4.30 p.m.	8.20 p.m.	Cod, .. Codling, .. Whiting, .. Plaice (1), .. " (2), .. Com. Dab, .. Starry Ray, .. Lumpsucker, ..	4 9 .. 9 249 —258 14 7 ..	.. 1 3 .. .. .. .. 1	4 10 3 .. .. 258 14 7 1	
									292	5	297	
5. Cruden Bay.	Mar. 27 and 28.	..	..	..	6-11	8.30 p.m.	12.45 a.m.	Cod, .. Codling, .. Whiting, .. Plaice (1), .. " (2), .. Flounder, .. Starry Ray, ..	2 4 2 7 163 —170 2 13	.. .. .. .. .. .. 5	2 4 2 .. .. 170 2 23	
									198	5	203	

TRAWLING INVESTIGATIONS—TABLE I.

No.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
Off burgh.	1905. Mar. 28.	..	..	..	6 to 10	5.20 a.m.	9.30 a.m.	Cod, .. .. Codling, .. .. Haddock, .. .. Whiting, .. .. Plaice (2), .. .. Com. Dab, .. .. Starry Ray, .. ..	5 1 3 7 16 40 4	.. .. .. 1 .. 19 2	5 1 3 8 16 59 6	
									76	22	98	
Off mouth Bath- tation.	"	..	..	..	6 to 10	7.40 p.m.	Mid- night.	Cod, .. .. Codling, .. .. Plaice, .. .. Turbot, .. .. Black Sole, .. ..	3 13 5 bskts. 1 1	.. .. .. .. ..	.. .. .. .. ..	Nearly half a basket unmarketable fish, mostly dabs.
									..	..	..	
1 miles Ardle- s.	Mar. 29.	..	..	..	18 to 25	6.20 a.m.	7.30 a.m.	Codling, .. .. Ling, .. .. Haddock, .. .. Whiting, .. .. Turbot, .. .. Plaice (2) .. .. Lemon Dab, .. .. Com. Dab, .. ..	9 3 .. .. 1 14 6 ..	.. .. 19 3 .. .. .. 21	9 3 19 3 1 14 6 21	Wind S.W., moderate breeze. Trawl-net torn.
									33	43	76	

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
1. Burghead Bay.	1905. Sept. 28.	..	..	..	5 to 12	6.15 a.m.	8.20 a.m.	Codling, ..	1	4	5	Wind N.E., moderate; sea choppy.
								Haddock (2), ..	73	1350	1423	
								Whiting, ..	4	43	47	Eleven squids.
								Gurnard, ..	..	34	34	
								Brill, ..	2	..	2	
								Plaice (1), ..	4	..	..	
								" (2), ..	7	..	..	
								" (3), ..	711	..	..	
								—722	16	738	..	
								Lemon Dab, ..	1	..	1	
								Com. Dab, ..	..	208	208	
								Angler, ..	..	12	12	
									803	1667	2470	
2. Dornoch Firth, off Dunrobin Castle.	"	..	52°2	54°0	5 to 15	1.55 p.m.	6.0 p.m.	Cod, ..	19	..	19	Wind N.E.; moderate breeze; sea choppy.
								Codling, ..	40	11	57	
								Haddock, ..	..	549	549	Fourteen squids.
								Whiting, ..	..	52	52	
								Gurnard, ..	..	51	51	
								Plaice (1), ..	23	..	..	
								" (2), ..	30	..	..	
								" (3), ..	775	..	..	
								—828	1267	2095	..	
								Lemon Dab, ..	14	..	14	
								Witch, ..	1	..	1	
								Com. Dab, ..	..	37	37	
								Long Rough Dab, ..	..	23	23	
								Thornback, ..	7	..	7	
								Angler, ..	..	4	4	
									915	1994	2909	
3. " " 29.	"	..	53°0	54°0	6 to 15	4.30 a.m.	8.30 a. .	Haddock (2), ..	24	400	424	
								Grey Gurnard, ..	..	15	15	
								Plaice (1), ..	10	..	..	
								" (2), ..	15	..	..	
								" (3), ..	727	..	..	
								—762	215	967	..	
								Lemon Dab, ..	12	..	12	
								Mackerel, ..	19	..	19	
								Thornback, ..	7	..	7	
									814	630	1444	
4. " " "	"	..	..	..	6½ to 15	10·5 a.m.	1.0 p.m.	Codling, ..	3	..	3	Five small squids.
								Haddock (1), ..	21	..	..	
								" (2), ..	15	..	..	
								—36	2255	2291	..	
								Whiting, ..	1	..	1	
								Grey Gurnard, ..	..	63	63	
								Plaice (1), ..	7	..	..	
								" (2), ..	86	..	..	
								" (3), ..	1030	..	..	
								—1123	1342	2465	..	
								Lemon Dab, ..	5	..	5	
								Mackerel, ..	1	..	1	
								Angler, ..	..	1	1	
								Thornback, ..	3	..	3	
									1172	3661	4833	



Loc.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
unroch sth. off unrobin isle.	1905. Sept. 29.	..	..	..	6 to 15	1.10 p.m.	5.15 p.m.	Codling, ..	5	..	5	Four squids.
								Haddock (1), ..	59	..	..	
								" (2), ..	63	..	..	
								Grey Gurnard, ..	122	1766	1888	
								Plaice (1), ..	..	82	82	
								" (2), ..	2	..	..	
								" (3), ..	100	..	..	
								..	1328	..	..	
								..	1430	2478	3908	
								Lemon Dab, ..	2	..	2	
								Com. Dab, ..	..	554	554	
								Angler, ..	..	5	5	
								Thornback, ..	..	3	3	
								..	1559	4888	6447	
unroch sth.	" 29.	..	..	..	8 to 15	5.55 p.m.	10.20 p.m.	Codling, ..	11	..	11	
								Haddock (1), ..	100	..	..	
								" (2), ..	41	..	..	
								Grey Gurnard, ..	141	3950	4091	
								Turbot, ..	..	79	79	
								Plaice (1), ..	1	..	1	
								" (2), ..	8	..	..	
								" (3), ..	38	..	..	
								..	708	..	..	
								..	754	869	1623	
								Lemon Dab (2), ..	6	..	6	
								Com. Dab, ..	..	177	177	
								Thornback, ..	3	..	3	
								..	916	5075	5991	
"	"	..	52°0	54°0	8 to 15	3.45 a.m.	8.0 a.m.	Codling, ..	12	1	13	
								Haddock (1), ..	90	..	..	
								" (2), ..	51	..	..	
								Grey Gurnard, ..	71	1047	1118	
								Plaice (1), ..	..	168	168	
								" (2), ..	4	..	..	
								" (3), ..	74	..	..	
								..	1195	..	..	
								..	1273	1279	2552	
								Lemon Dab, ..	11	..	11	
								Com. Dab, ..	7	60	67	
								Mackerel, ..	3	..	3	
								Angler, ..	..	6	6	
								Thornback, ..	1	..	1	
								..	1373	2561	3939	
side romarty sth.	"	..	52°0	53°0	12	12 noon.	2.20 p.m.	Cod, ..	2	..	2	
								Codling, ..	4	3	7	
					</							

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remark
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
9. Burghhead Bay.	1905. Oct. 2.	..	..	..	5 to 12	2.45 a.m.	7.30 a.m.	Cod, .. .. . Codling, .. .. Haddock (2), .. Whiting (2), .. Grey Gurnard, .. Brill, .. .. . Plaice (1), .. .. " (2), .. .. . " (3), .. .. . — Lemon Dab (1), .. Witch (1), .. .. Com. Dab, .. .. Angler, .. .. . Thornback, .. ..	1 3 29 13 .. 9 5 167 1022 —1194 10 7 206 .. 7	.. 4 1305 .. 159 .. .. .. .. 206 .. 28 ..	1 7 1334 13 159 9 .. .. 1400 10 7 866 28 7	Five squids.
10. "	"	..	..	..	8 to 12	11.55 a.m.	4.0 p.m.	Codling, .. .. Haddock, .. .. Whiting, .. .. Gurnard, .. .. Brill, .. .. . Plaice (1), .. .. " (2), .. .. . " (3), .. .. . — Lemon Dab, .. .. Com. Dab, .. .. Angler, .. .. . Thornback, .. ..	.. .. .. .. 7 8 149 378 —535 4 39 .. 6	9 56 14 12 .. .. .. 24 .. 81 4 ..	9 56 14 12 7 .. .. 559 4 120 4 6	Wind N.W., erate b sea moder
11. "	Oct. 2, 3.	..	..	..	"	8.15 p.m.	12.30 a.m.	Cod, .. .. . Turbot, .. .. Brill, .. .. . Plaice (1), .. .. " (2), .. .. . " (3), .. .. . — Lemon Dab, .. .. Witch (1), .. .. Com. Dab, .. .. Thornback, .. ..	3 2 5 4 273 723 —1000 7 3 29 10	.. .. .. .. .. .. .. .. .. .. .. ..	.. .. .. .. .. .. .. .. .. .. .. ..	Unmarket fishes filled baskets.
12. "	Oct. 3.	..	..	..	10 to 15½	6.0 a.m.	10.10 a.m.	Codling, .. .. Haddock, .. .. Whiting, .. .. Gurnard, .. .. Plaice (1), .. .. " (2), .. .. . " (3), .. .. . — Com. Dab, .. .. Long Rough Dab, Angler, .. .. .	1 .. .. .. 1 7 41 —49 12 .. ..	5 47 10 22 .. .. .. 13 36 7 5	6 47 10 22 .. .. .. 62 48 7 5	Net split bad

No.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.	
		Air.	Surface.	Bottom.		Shot.	Hauled	Name.	No. taken to Market.	No thrown Over-board.	Total No.		
1	1905. Oct. 3.	..	..	..	8 to 15 1/2	10.50 a.m.	3.30 a.m.	Codling, ..	..	11	11	Net split badly. Fifteen squids.	
								Haddock, ..	..	378	378		
								Whiting, ..	..	52	52		
								Gurnard, ..	..	28	28		
								Brill, ..	2	..	2		
								Plaice (1), ..	15	..	..		
								" (2), ..	62	..	..		
								" (3), ..	107	..	..		
								—184	82	266	..		
								Com. Dab, ..	24	107	131		
								Black Sole, ..	1	..	1		
								Long Rough Dab, ..	..	6	6		
								Angler, ..	5	2	7		
								216	666	882	..		
2	"	..	..	..	8 to 14	4.25 p.m.	8.45 p.m.	Codling, ..	1	8	9		Wind W., strong breeze.
								Haddock (1), ..	5	96	101		
								Grey Gurnard, ..	..	216	216		
								Turbot, ..	1	..	1		
								Brill, ..	12	..	12		
								Plaice (1), ..	8	..	..		
								" (2), ..	187	..	..		
								" (3), ..	817	..	..		
								—1012	208	1220	..		
								Lemon Dab, ..	1	..	1		
								Com. Dab, ..	130	492	622		
								Long Rough Dab, ..	..	36	36		
								1162	1056	2218	..		
3	Oct. 4.	..	..	..	8 to 13	7.30 a.m.	11.45 a.m.	Codling, ..	..	9	9		
								Haddock (1), ..	2	..	..		
								" (2), ..	26	..	..		
								—28	325	353	..		
								Whiting, ..	..	47	47		
								Grey Gurnard, ..	..	43	43		
								Brill, ..	3	..	3		
								Plaice (1), ..	2	..	..		
								" (2), ..	111	..	..		
								" (3), ..	577	..	..		
								—690	102	792	..		
								Lemon Dab, ..	5	..	5		
								Witch (1), ..	10	4	14		
								Com. Dab, ..	108	160	268		
								Long Rough Dab, ..	..	14	14		
								Black Sole, ..	1	..	1		
								Angler, ..	5	6	11		
								Thornback, ..	4	5	9		
								854	715	1569	..		
4	"	..	..	..	8 to 13	5.30 p.m.	10						

TRAWLING INVESTIGATIONS—TABLE I.

Place.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
1. Burg- head Bay.	1905. Nov. 1	46.4	48.9	49.0	8 to 10	5.15 p.m.	8.20 p.m.	Codling, .. ..	..	23	23	Wind E., mo- sea moder
								Haddock, .. ..	..	2852	2852	
								Whiting, .. ..	..	90	90	
								Gurnard, .. ..	..	117	117	
								Turbot, .. ..	1	..	1	
								Brill, .. ..	7	..	7	
								Plaice (2), .. ..	149	..	..	
								" (3), .. ..	530	..	..	
								Com. Dab, .. ..	679	326	1005	
								Long Rough Dab, ..	86	136	222	
								Thornback, .. ..	7	..	7	
									780	3551	4331	
2. "	Nov. 2.	45.7	48.4	49.0	8 to 13	5.0 a.m.	8.15 a.m.	Codling, .. ..	..	47	47	Wind N.E., s sea rough.
								Haddock, .. ..	..	2748	2748	
								Whiting, .. ..	..	198	198	
								Gurnard, .. ..	..	204	204	
								Plaice (2), .. ..	59	..	..	
								" (3), .. ..	242	..	..	
								Com. Dab, .. ..	301	144	445	
								Thornback, .. ..	21	194	215	
									2	..	2	
									324	3535	3859	
3. Dornoch Firth.	"	46.8	49.1	48.5	8 to 13	10.20 a.m.	1.30 p.m.	Cod, .. ..	7	..	7	
								Codling, .. ..	12	..	12	
								Haddock (2), .. ..	25	..	..	
								" (3), .. ..	63	..	..	
								Whiting, .. ..	88	2270	2358	
								Coal-fish, .. ..	14	..	14	
								Gurnard, .. ..	1	..	1	
								Plaice (2), .. ..	..	27	27	
								" (3), .. ..	17	..	..	
								Lemon Dab, .. ..	34	..	..	
								Com. Dab, .. ..	51	18	69	
									6	8	14	
									9	46	55	
									188	2369	2557	
4. "	"	..	..	..	6 to 10	2.40 p.m.	6.0 p.m.	Cod, .. ..	2	..	2	
								Codling, .. ..	11	18	29	
								Haddock (2), .. ..	39	..	..	
								" (3), .. ..	20	..	..	
								Whiting, .. ..	59	582	641	
								Gurnard, .. ..	12	106	118	
								Plaice, .. ..	..	14	14	
								Com. Dab, .. ..	143	39	182	
								Angler, .. ..	..	26	26	
									..	1	1	
									227	786	1013	
5. Off Lybster.	Nov. 3.	..	..	..	18 to 30	4.0 a.m.	7.20 a.m.	Cod, .. ..	40	..	40	
								Codling, .. ..	62	1	63	
								Haddock, .. ..	..	28	28	
								Whiting, .. ..	..	13	13	
								Gurnard, .. ..	..	202	202	
								Plaice, .. ..	8	2	10	
									110	246	356	

TRAWLING INVESTIGATIONS—TABLE I.

e.	Date.	Temperature.			Depth in Fms.	Time Trawl Down.		Fish Caught.				Remarks.
		Air.	Surface.	Bottom.		Shot.	Hauled.	Name.	No. taken to Market.	No. thrown Over- board.	Total No.	
Lurg- Bay.	1905. Nov. 4.	..	..	..	6 to 10	10.55 a.m.	3.0 p.m.	Haddock, .. ..	..	332	332	Wind S.E., strong breeze; sea rough.
								Whiting, .. ..	..	22	22	
								Gurnard, .. ..	..	36	36	
								Brill, .. ..	2	..	2	
								Plaice, .. ..	535	21	556	
								Com. Dab, .. ..	4	71	75	
								Long Rough Dab,	..	3	3	
									541	485	1026	
"	"	"	"	"	5 to 9	3.45 p.m.	7.50 p.m.	Cod, .. ..	1	..	1	
								Codling, .. ..	..	5	5	
								Haddock, .. ..	..	606	606	
								Whiting, .. ..	..	52	52	
								Gurnard, .. ..	..	19	19	
								Turbot, .. ..	3	..	3	
								Brill, .. ..	2	..	2	
								Plaice, .. ..	1015	31	1046	
								Witch, .. ..	1	..	1	
								Com. Dab, .. ..	12	104	116	
								Angler, .. ..	..	4	4	
								Thornback, .. ..	3	..	3	
									1037	821	1858	
"	Nov. 6.	..	..	..	5 to 9	6.0 a.m.	10.0 a.m.	Codling, .. ..	1	8	9	Wind E.N.E.; heavy sea.
								Haddock, .. ..	..	57	57	
								Whiting, .. ..	..	15	15	
								Gurnard, .. ..	..	71	71	
								Turbot, .. ..	4	..	4	
								Brill, .. ..	7	..	7	
								Plaice, .. ..	695	38	733	
								Com. Dab, .. ..	16	115	131	
								Long Rough Dab,	..	2	2	
									723	306	1029	

## II.—OBSERVATIONS ON THE OTOLITHS OF SOME TELEOSTEAN FISHES.

By THOMAS SCOTT, LL.D., F.L.S., Mem. Soc. Zool. de France.

(PLATES I.-V.)

### CONTENTS.

	PAGE.
(1) Preliminary Remarks, . . . . .	48
(2) List of Fishes whose Otoliths are described, . . . . .	52
(3) Systematic description of the Otoliths, . . . . .	53
(4) Literature bearing on the Otoliths of Fishes, . . . . .	80

### I.—PRELIMINARY REMARKS.

Rather more than twenty-five years ago a portion of my leisure was devoted to a study of the post-tertiary and surface geology of the Clyde Valley. Consequently, the rich fossiliferous beds that were exposed about that time in connection with the excavations for the James Watt Wet Dock at Greenock were of special interest to me as well as to all engaged in this study. It was about that time and in connection with these researches that my attention was first directed to those curious bodies known as the otoliths, or earstones of fishes.

These studies had made me acquainted with the late Dr. David Robertson, of Glasgow, and subsequently of Millport, whose name is so intimately associated with the Marine Biological Station at the latter place. This gentleman, who already possessed large collections of natural history objects of various kinds, had among them an extensive series of the otoliths of recent and known fishes, and these collections I had the frequent privilege of inspecting.

If I remember rightly, one of the reasons which induced Dr. Robertson to make this collection of otoliths was that such objects were expected to occur, or had already been noticed, in the fossiliferous clays then under examination, and that, therefore, a familiarity with the recent forms might help in identifying the kinds of fishes such fossil otoliths might belong to.

With Dr. Robertson's assistance, always freely given to those engaged in natural history pursuits, I soon became interested in these things. Later on, when carrying out the work assigned to me by the Fishery Board for Scotland, the food of fishes engaged my attention from time to time, and in order to obtain the information desired it was necessary to examine the stomachs of many of the fishes captured. As this examination proceeded it became manifest that small fishes were often captured by the larger specimens for food, as their remains sometimes formed a considerable proportion of the contents of the stomachs examined. Frequently, however, the otoliths or earstones were the only parts that remained, or that were least affected by the action of the digestive fluid; it was therefore obvious that a familiarity with the earstones of fishes

already known might be useful as a means whereby we could ascertain what was the species of fish that those found in the stomachs belonged to.

Of course, the usefulness of the earstones for this purpose depends on whether the difference between those of one species of fish and those of another is sufficiently distinct and constant, either in their size, form, or sculpture. This information, however, could only be acquired by the comparative examination of the earstones of many kinds of fishes and also of large and small examples of the same kinds. Unfortunately, I have not been able to give so much attention to this research as it deserved, nevertheless a good deal of time has been devoted to it, and though the results have been in some respects disappointing, several interesting facts have emerged which will be referred to presently.

The earstones of about seventy species of fish are described in the sequel and, with one or two exceptions, the descriptions are illustrated by enlarged photographs. Before proceeding, however, to describe the various forms, the following remarks may not be out of place, and the first thing I wish to refer to is the *position* of the earstones.

The earstones or otoliths of teleostean fishes are contained within special chambers—the ear-chambers—one on each side of the head and situated between the eye and the base of the skull. There are usually several stones in each chamber, one being comparatively large and the others very small. The form of the large stone is generally well defined, but the others are irregular in shape, and therefore, in this paper, the term *earstone* or *otolith* will refer only to the large stone. The otoliths are not outgrowths from adjoining parts of the skull, but are free within the ear cavity, and are covered by a thin membrane to which nerves are attached.

I have endeavoured to ascertain whether the size of the earstones was in any way correlated with the intensity of the sense of hearing, that is, whether the possession of large or small earstones was an indication of a higher or lower development of the sense of hearing, but have been unable to obtain any positive evidence bearing on this question. For example, haddock, coal fish (especially in the earlier stages), lythe, and also cod have their sense of hearing tolerably acute. This was demonstrated over and over again at the Rothesay Aquarium, and these fish have large earstones. The conger, on the other hand, which has comparatively small earstones, appears to be a dull and listless fish. But it has been noticed that lumpsuckers, and more especially the young of that species, have a keenly intelligent look, yet their earstones are extremely small compared with the size of the fish.

The position which the earstones *in situ* occupy in relation to the head of the fish has been observed in a number of cases, and is referred to in the descriptive part of the paper. It may be stated here, however, that in the majority of species where careful observation could be made, it was observed that the two earstones were placed lengthways, or nearly so, with the head. They were not, however, usually parallel to each other, but diverged more or less posteriorly. In the case of many of the larger fishes—except the Pleuronectidæ—the earstones are elongated, and have one end truncated, often obliquely, and the other end angular or produced to a more or less sharp point, as is well exemplified by those of the whiting. The truncated end is usually directed towards the front of the head, but there are a few fishes, such as the herring and some others, where the anterior end is pointed. It may also be remarked that the earstones in these larger fishes have frequently one side concave and the other convex. The convex sides usually face each other, and are com-

paratively smooth, while any sculpture with which the earstone may be ornamented is more frequently found on the outer or concave side. The upper margin of the earstone is also the one which is likely to have the edge notched or crenulated, whereas the lower margin is often tolerably even and gently curved.

The earstones of the Pleuronectidæ are generally more or less circular and sometimes nearly circular, in other cases they are broadly oval, and they are nearly always flat and thin. Their true position in relation to the head is, for this reason, and also because of the remarkable change that takes place in order that both eyes may be accommodated on the same side, not so obvious as in the case of those whose eyes retain their normal position.

Secondly, a few general remarks about the size, structure, and form of the earstones of different fishes and their value as a means for the identification of species may be useful here. As already stated, it is many years ago since the earstones of fishes were taken up as a systematic study. This study was undertaken for the purpose of ascertaining if, failing other evidence, the species of a fish could be determined by the earstones alone. I soon became satisfied that, except in certain cases, they could not be altogether relied upon for this purpose, especially when dealing with young fishes whose otoliths have not yet attained the form and structure peculiar to the adult. But though it may frequently be difficult to distinguish the *species* of a fish where the otoliths are the only parts left by which it may be identified, yet they may be fairly reliable as a guide for ascertaining the family and also sometimes the genus to which the fish belongs. It is not difficult, for example, to distinguish the earstones of the more typical of the Gadoids, and especially of those of most of the genus *Gadus*—they are usually so massive in structure as to differ in this respect alone from those of almost all other groups of fishes with which I am familiar. Yet there are one or two species belonging to this family that possess earstones so different from those of the genus *Gadus*, that if it were the case that no other parts of the fishes were available for determining the family they belonged to, one would be inclined to ascribe them to some other than that of the gadidæ. I have already referred to the family Pleuronectidæ as possessing earstones more or less rotundate, flat and thin, and thus presenting characters by which they differ from most of the other teleostean fishes mentioned here. But though the peculiarities in shape and structure that characterise the earstones of fishes may not generally be reliable for the identification of species when unsupported by other evidence, still there are several fishes that possess otoliths so distinct, that by means of them alone the species may be determined with almost absolute certainty. In support of this statement I need only refer to the following species:—The earstones of the black goby, *Gobius niger*, possess characters by which they may be distinguished with tolerable certainty from those of other fishes. They are nearly flat, and of a broadly rhomboid form, as may be seen on pl. ii. B., figs. 19 and 20, and pl. V., fig. 6.

The earstones of the whiting have also a form unlike that of the otoliths of any other fishes known to me; they are considerably elongated, and are obliquely truncate at one end, while the opposite end is drawn out into a tapering extremity which ends in a sharp point (*see* figs. 30 and 31 on pl. ii. A.).

The hake has earstones so different in shape and so thin that when placed beside the massive otoliths of the cod and coal-fish, belonging to the same family, they suggest doubts as to whether these species are so closely related to one another as their position indicates.



The megrim or whiff is the only kind of fish I have met with that exhibits a fairly constant difference in the shape of the right and left earstones. At first I imagined this difference to be merely accidental, but the examination of several specimens, both large and small, revealed similar differences in all of them.

The earstones of the argentine have also a peculiar shape, and are unlike any of those that have been examined. They may be described as scaphoid or boat-shaped, except that the length and depth are nearly the same. Two pairs of these earstones are represented on pl. i. B., figs. 44 and 45, and photographs of them considerably enlarged will be found on pl. iv., fig. 9.

The earstones of very young and immature fishes may, but frequently do not, possess the characters peculiar to the species as seen in the adult form, and it is this fact that makes the identification of fishes by the earstones alone unsatisfactory, whereas if the fishes be of adult size, or nearly so, the uncertainty of determination is greatly minimised. There can, for example, be little or no difficulty in recognising the earstones of adult whiting or codfish or of those of the hake.

Besides the difference in the shape of the earstones of fishes there is also sometimes considerable differences observed in the proportional sizes of those of different fishes—that is, it does not always follow that a large fish belonging to one species will have earstones proportionally larger than a smaller fish belonging to another species, for we sometimes find that the difference is the other way. For example, the earstones of a lumpsucker fifteen and a half inches long measured 1.5mm. by 1.3mm.; a lemon dab twelve inches long had earstones that measured 3.5mm. by 2mm., while those of a long rough dab ten inches long, or only two-thirds the length of the lumpsucker, measured 6mm. by about 4.5mm—four times the size of those of the lumpsucker. Then, again, a catfish, the length of which was twenty-seven inches, possessed earstones 4mm. long by 2.5mm. at the widest part, while a hake of about the same length as the catfish was found to have earstones nearly 25mm. long by about 9mm. at the widest part. In further contrast with the earstones of the fishes just mentioned, it may be stated that a codfish measuring fully three feet in length had earstones of about the same width as those of the hake, but they were nearly 7mm. shorter, their length reaching only to 18mm., but the difference in length was fully made up by their more massive structure. The weight of these two earstones was about 22 English grains, or, more correctly, 1.485 grammes, while the weight of the two otoliths from the hake was about 12 English grains, or .735 grammes. It may also be mentioned that the two earstones of a codfish which measured forty inches in length weighed nearly 30 English grains—and it should be noted that this was the weight of them after they had been thoroughly dried.

Moreover, the earstones of teleostean fishes appear to consist almost entirely of calcareous matter, for when those from a tolerably large codfish were subjected to a red heat they remained practically unaltered in size or in shape, but were so brittle that they were easily crushed between the finger and thumb. On the other hand, when otoliths were placed in dilute hydrochloric acid they completely dissolved away with much effervescence, leaving but the merest trace of organic matter.

This calcareous matter does not form a homogeneous mass, but is deposited in layers, and the density of each alternate layer is usually less or greater than the one immediately preceding. In some cases these layers are arranged so regularly as to imply a more or less regular and periodic activity or quiescence in the secreting tissues by which the earstones are formed. The result of this alternating activity and quiescence

is well seen in the structure of the otoliths of several species of the Pleuronectidæ, the shape of which is more or less circular, and they are so thin as to be almost transparent, especially when just removed from the ear-chamber. It is evident that the calcareous matter that is added to these earstones from time to time is deposited chiefly around the circumference, and only to a small extent laterally. In several of the Gadidæ, on the other hand, considerable additions are made to the thickness as well as round the edges of the otoliths. In not a few other fishes the form of the earstones is so irregular that the calcareous matter of which they are composed cannot have been added symmetrically as in the case of the earstones of the Pleuronectidæ.

An attempt is being made to utilise these concentric growth-lines for the purpose of ascertaining the age of the fish they belong to, somewhat after the manner a botanist reckons the age of an exogenous tree by counting the number of alternating light and dark rings exhibited in a cross section of the wood; and it is probable that an estimate of the fish's age founded on these growth-lines may be approximately correct as regards plaice or any other fish whose earstones have a regular form and are sufficiently thin to show the concentric lines clearly. But it is doubtful how far such a method can be relied upon if applied to such fish as the bream, mullet, hake, herring, and others having earstones irregular in shape. Moreover, it is probable that the abundance or scarcity of food that the fish have to live upon, or variations in the kinds of the food, may retard or quicken the deposition of calcareous matter, and may lead to the formation of pseudo rings, whole or incomplete, that may tend to complicate or in some measure to nullify the calculation.

The discussion of these questions is, however, outside the scope of the present paper, which is merely intended to contain notes descriptive of the sizes and forms of the earstones of a number of the fishes that have come under my own observation.

The plates which illustrate this paper were prepared from photographs made by my son, Andrew Scott, A.L.S. The earstones represented by the photographs were collected at various times and mounted on slides, by myself, but only a limited number of them were selected for mounting. Those represented on Plates I., II., and III. are nearly twice the natural size, while Plates IV. and V. show them considerably enlarged.

## II.—LIST OF FISHES WHOSE EARSTONES ARE DESCRIBED IN THE PRECEDING NOTES—ALPHABETICALLY ARRANGED.

	PAGE.
<i>Agonus cataphractus</i> (Linn.), Pogge, . . . . .	56
<i>Ammodytes tobianus</i> , Linn., Lesser sand-eel, . . . . .	69
<i>Anarrhichas lupus</i> , Linn., Catfish, . . . . .	59
<i>Anguilla vulgaris</i> , Leach, Fresh-water eel, . . . . .	79
<i>Argentina sphyæna</i> , Linn., Argentine, . . . . .	76
<i>Atherina presbyter</i> , Cuv., Sand smelt, . . . . .	60
<i>Bothus maximus</i> (Linn.), Turbot, . . . . .	70
<i>Callionymus lyra</i> , Linn., Dragonet, . . . . .	58
" <i>maculatus</i> , Bonepart, Spotted dragonet, . . . . .	58
<i>Clupea harengus</i> , Linn., Herring, . . . . .	77
" <i>pilchardus</i> , Bloch., Pilchard, . . . . .	78
" <i>sprattus</i> , Linn., Sprat, . . . . .	78
<i>Conger niger</i> (Risso), Conger-eel, . . . . .	79
<i>Coregonus lavaretus</i> , Penn., Powan, . . . . .	76
<i>Cottus scorpius</i> , Linn., Sea scorpion, . . . . .	55
<i>Cyclopterus lumpus</i> , Linn., Lump-sucker, . . . . .	59
<i>Drepanopsetta platessoides</i> (Fabr.), Long rough dab, . . . . .	69
<i>Enchelyopus viviparus</i> (Linn.), Viviparous blenny, . . . . .	60
<i>Esox lucius</i> , Linn., Fresh-water pike, . . . . .	77

	PAGE.
<i>Gadus aeglefinus</i> , Linn., Haddock,	62
„ <i>callarias</i> , Linn., Codfish,	61
„ <i>Esmarkii</i> , Nilsson, Norway pout,	64
„ <i>luscus</i> , Linn., Brassy,	63
„ <i>merlangus</i> , Linn., Whiting,	65
„ <i>minutus</i> , Linn., Poor cod,	64
„ <i>pollachius</i> , (Cuv.), Pollack,	66
„ <i>poutassou</i> , Risso, Couch's whiting,	64
„ <i>irens</i> , Linn., Coalfish,	65
<i>Gobius minutus</i> , Smel., Speckled goby,	58
„ <i>niger</i> , Linn., Black goby,	58
<i>Hippoglossus vulgaris</i> , Flem., Halibut,	69
<i>Labrus bergylla</i> , Ascan., Ballan wrasse,	61
„ <i>mixtus</i> , Linn., Striped wrasse,	61
„ <i>rupestris</i> , Linn., Jago's goldsinny,	61
<i>Lepidorhombus whiff</i> , (Walb.), Megrim,	71
<i>Leuciscus rutilus</i> , Linn., Roach,	77
<i>Lophius piscatorius</i> , Linn., Angler fish,	57
<i>Lumpenus lampretiformis</i> , (Walb.), Sharp-tailed lumpenus,	60
<i>Merluccius merluccius</i> , Linn., Hake,	66
<i>Molva molva</i> (Linn.), Ling,	67
<i>Mugil chelo</i> , Cuv., Thick-lipped grey mullet,	60
<i>Mullus barbatus</i> , Linn., Red mullet,	54
<i>Nerophis lumbriciformis</i> , Will., Worm pipefish,	79
<i>Onos cimbrius</i> (Linn.), Four-bearded rockling,	67
„ <i>tricirratu</i> s (Brün.), Three-bearded rockling,	67
<i>Perca fluviatilis</i> , Linn., Fresh-water perch,	53
<i>Photis gunnellus</i> , Linn., Butterfish,	59
<i>Phycis blennoides</i> , Brün., Greater fork-beard,	66
<i>Platophrys laterna</i> (Walb.), Scaldfish,	72
<i>Pleuronectes cynoglossus</i> , Linn., Witch sole,	74
„ <i>fleus</i> , Linn., Flounder,	73
„ <i>limanda</i> , Linn., Dab,	74
„ <i>microcephalus</i> , Don., Lemon sole,	73
„ <i>platessa</i> , (Linn.), Plaice,	72
<i>Raniceps raninus</i> (Linn.), Lesser fork-beard,	68
<i>Salmo</i> (?) <i>fario</i> , Linn., Brown trout,	76
„ <i>salar</i> , Linn., The salmon,	76
<i>Scomber scombrus</i> , Linn., Mackerel,	57
<i>Scorpena dactyloptera</i> , De la Roche, Blue mouth,	55
<i>Sebastes norvegicus</i> , (Ascan.), Norway haddock,	54
<i>Solea lutea</i> , Risso, Solenette,	75
„ <i>variegata</i> , Don., Variegated sole,	75
„ <i>vulgaris</i> , Guensel., Black sole,	75
<i>Sparus centrodontus</i> , De la Roche, Common sea bream,	54
<i>Trachinus draco</i> , Linn., Greater weaver,	57
„ <i>vipera</i> , Cuv., Lesser weaver,	57
<i>Trigla gurnardus</i> , Linn., Grey gurnard,	55
„ <i>lineata</i> , Gmel., Streaked gurnard,	56
„ <i>lucerna</i> , Linn., Sapphirine gurnard,	56
„ <i>pini</i> , Bloch, Red gurnard,	56
<i>Zeugopterus punctatus</i> , Bloch, Müller's top-knot,	71

### III.—SYSTEMATIC DESCRIPTION.

Nomenclature followed.—*A History of Scandinavian Fishes*, by B. Fries, C. U. Ekström, and C. Sundevall, 2nd edit., revised by Prof. F. A. Smitt (1893-95).

Arrangement followed.—Dr. Francis Day, *The Fishes of Great Britain and Ireland*, 2 vols. (1880-84).

#### Fam. PERCIDÆ.

##### Genus *Perca*.

*Perca fluviatilis*, Linn. Fresh-water Perch. Pl. iii. B., figs. 54-57; pl. v., fig. 13.

Four specimens of the fresh-water perch were examined—one about 14 inches long, one 8 inches, one 7 inches, and one  $6\frac{1}{2}$  inches. The earstones of the largest specimen measured 10.5mm. in length and about 5.5mm. at the widest part, while those of the other three specimens measured respectively 7mm. by 3.5mm. and 6mm. by 3mm. The larger earstones are thus proportionally the shorter ones, the first being equal to about one thirty-fourth part of the entire length of the fish, the next about the one-thirtieth, and the last rather longer. These earstones are very irregular in outline, and the greatest width is towards the posterior end. The lower margin is tolerably even and slightly arcuate, but the upper is irregular, with a prominent notch near the proximal end; this end is narrow and bluntly rounded. Both the posterior end and the upper margin are distinctly but irregularly crenulate; they are also moderately compressed and thin. The earstones of the smaller fishes have a general resemblance to those of the large one, but they are distinctly less crenulated, and the surface is not so rugose. The specimens seem to vary to some extent in form and sculpture.

Fam. MULLIDÆ.

Genus *Mullus*.

*Mullus barbatus*, Linn. Surmullet or Red Mullet. Pl. iii. B., fig. 49; pl. v., fig. 23.

The fish from which the earstones were taken measured scarcely  $8\frac{1}{2}$  inches in length. The earstones are broadly ovate in outline, the posterior extremity is truncated, while the proximal end is narrow and bluntly rounded; the lateral margins are obscurely crenulate, and the surface is somewhat rugose. The earstones of the red mullet are apparently proportionally smaller than those of the fresh-water perch. Those just described measured only about 4.5mm. long by about 3mm. in greatest width, and are thus about equal to little more than one-fiftieth part of the length of the fish.

Fam. SPARIDÆ.

Genus *Sparus*.

*Sparus (Pagellus) centrodontus*, De la Roche. Sea Bream. Pl. ii. B., figs. 6 and 7.

The earstones of two examples of this species are shown on Plate ii. B. The larger of the two fishes measured 17 inches in length, and the smaller 15 inches. The earstones of the first (fig. 6) measured 15.5 mm. along their greatest length, and 8mm. in depth, and those of the smaller one (fig. 7) 14mm. by 7.5mm. In their outline and markings these earstones are somewhat similar to those of the large fresh-water perch, but the lower margin is rather more arcuate, and they are more incurved when seen from above. They are also considerably larger in proportion to the length of the fish, being about one twenty-seventh or twenty-eighth part of the extreme length.

Fam. SCORPÆNIDÆ.

Genus *Sebastes*.

*Sebastes norvegicus* (Ascan.). Norway Haddock. Pl. iii., B., figs. 50–52.

The earstones of three small examples of *Sebastes* are represented on Plate iii. B. The fishes measured 5 inches,  $5\frac{1}{2}$  inches, and 6 inches in

length respectively. The earstones, which are tolerably flat, are broadly oval in outline, those of the largest of the three fishes (fig. 50) measure fully 7mm. in length and 4·5mm. in width, the greatest width being near the middle. The lower margin is moderately convex and even, the posterior end is broadly truncate, but the proximal end terminates in a short narrow process; the upper margin, from the posterior end forward to about the middle of the otolith is slightly arcuate and even, but it then slopes abruptly towards the narrow proximal extremity. The lateral surfaces are moderately smooth. The earstones of the smallest of the three fishes (fig. 51) measure 6·4mm. by 4mm., and closely resemble the others in form and sculpture. The earstones of these young *Sebastes* are comparatively as large as those of the sea bream.

#### Genus *Scorpena*.

*Scorpena dactyloptera*, De la Roche. The Blue-mouth. Pl. iii. B., fig. 53.

The earstones of a *Scorpena* 14 inches long are represented by the photograph (fig. 53). They are moderately large, measuring 14mm. in length and about 6·7mm. in width, the greatest width being a little in front of the middle. The lower margin is tolerably arcuate and obscurely crenated; the posterior extremity is truncated, and the margin slopes obliquely forward. The proximal portion of the earstone is moderately long and narrow; the upper margin, which is obscurely crenate or lobed, extends from the posterior angle in a nearly straight line, slightly diverging from the lower margin, to a little beyond the middle, where it terminates in an abrupt break, and from this break to the anterior extremity the earstone is comparatively narrow. Both the inner and outer sides of the earstones are nearly smooth. These earstones were equal to about one-twenty-fifth part of the entire length of the fish.

#### Fam. COTTIDÆ.

#### Genus *Cottus*.

*Cottus scorpius*, Linn. Sea Scorpion. Pl. iii. B., figs. 63–65.

The earstones represented by fig. 63 (Pl. iii. B.), and which are about 6mm. in length by 3mm. in depth, were obtained from a large variety of *Cottus scorpius* (var. *grælandicus*), but the size of the fish was not recorded. The middle portion of the lower margin is nearly straight, then it turns slightly upwards at both ends; the upper margin is nearly parallel with the middle portion of the lower, but this part of the upper margin, beginning at the posterior end, extends only to a little beyond the middle of the otolith, where it terminates somewhat abruptly, the remaining part of the otolith being narrow and ending in a moderately sharp-pointed extremity. The posterior end is bluntly rounded. A second and more typical specimen of *C. scorpius*, which measured 6½ inches in length, had earstones only a little smaller than the other, their form being also slightly different (fig. 65). Fig. 64 represents the otoliths of a very small *Cottus* belonging to the same species.

#### Genus *Trigla*.

*Trigla gurnardus*, Linn. The Grey Gurnard. Pl. i. B., figs. 46–52; pl. iv., figs. 12 and 13.

The earstones of seven fishes of different sizes are represented on Plate i. B. The largest fish was about 15 inches in length and the smallest 7 inches, but though the earstones differ considerably in size they retain to a large extent their characteristic form and sculpture. Their general outline may be thus briefly described. The upper and lower margins are arcuate, but the one rather more so than the other. One end is obliquely truncated, while the other is bifid or forked, and a distinct groove extends from the apex of the fork to almost the opposite end of the earstone. The earstones from the largest fish (15 inches long) measured 4.8mm. in length by about 4mm. in depth, and are thus comparatively small in proportion to the size of the fish, being only equal to an eightieth part of its length. They are represented by fig. 46. The other fishes in the series measure about  $13\frac{1}{2}$  inches,  $13\frac{1}{4}$  inches,  $12\frac{1}{2}$  inches,  $9\frac{1}{2}$  inches,  $7\frac{1}{2}$  inches, and 7 inches in length, and the length of their earstones stated in the same order is nearly 4.5mm., 4.0mm., 4.3mm., 3.0mm., 2.7mm., and 2.5mm., their greatest width being about one-fifth less than the length. They were all nearly flat or only slightly incurved. Figs. 12 and 13, pl. iv., represent figs. 50 and 51, on pl. i., B., considerably enlarged.

*Trigla pini*, Bloch. The Red Gurnard. Pl. i. B., fig. 53; pl. iv., fig. 15.

The earstones represented by fig. 53 are from a red gurnard 345mm. (nearly  $13\frac{3}{4}$  inches) in length. They have a general resemblance to those of the grey gurnard, except that the lower margin is produced posteriorly into a sharp point. The extreme length of the earstones is about 5.5mm. by 3.5 in depth. Fig. 15, pl. iv., shows the earstones considerably enlarged.

*Trigla lineata*, Gmel. The Streaked Gurnard. Pl. i. B., figs. 54 and 55; pl. iv., fig. 20.

The two specimens of *Trigla lineata* whose earstones are represented here measured respectively  $10\frac{1}{4}$  inches and 8 inches in length. The otoliths, which do not differ much in size, being about 4mm. long by fully 2.5mm. in depth, are in their form and markings somewhat similar to those of *Trigla gurnardus*. Fig. 20, pl. iv., shows the earstones, represented by fig. 54, greatly enlarged.

*Trigla lucerna*, Linn. The Sapphirine Gurnard. Pl. i. B., fig. 56; pl. iv., fig. 21.

The earstones of these species have also a general likeness to those of *Trigla gurnardus*. The specimen from which those represented here was obtained measured  $10\frac{1}{2}$  inches long, and the earstones were about 3.8mm. by 2.5mm.

#### Fam. CATAPHRACTIDÆ.

##### Genus *Agonus*.

*Agonus cataphractus*, Linn. The Pogge. Pl. ii. B., fig. 18; pl. iii. B., figs. 44-46; pl. v., fig. 27.

Four examples of *Agonus* ranging from about 6 inches to  $4\frac{1}{2}$  inches in length were examined for their earstones. These were found to have a narrow oval form, rather obtuse at the one end and pointed at the other

Those of the largest fish measured 5·4mm. in length by about 2mm. in depth (see fig. 45, pl. iii. B.), while those of the smallest (fig. 18, pl. ii. B.) measure 5mm. by about 2mm. It will be noticed that the earstones of the poggæ are moderately large in proportion to the length of the fish. Those of the smallest specimen are about the one twenty-third part of its entire length.

Fam. PEDICULATIDÆ.

Genus *Lophius*.

*Lophius piscatorius*, Linn. The Angler-fish. Pl. iii. B., figs. 61 and 62 ; pl. iv., fig. 31 ; pl. v., fig. 19.

The earstones from a fairly large angler, 36 inches long, are represented by fig. 61 on pl. iii. B. They are comparatively broad, and their outline is somewhat irregular; the lower margin, which has a stout rib extending nearly from end to end, is obtusely geniculated, the angular part being nearly intermediate between the two extremities. The upper margin is arcuate and thin, and at the anterior end where it meets the lower margin it forms a blunt-pointed angle, but the posterior end is obliquely truncated. Numerous and somewhat obscure lines radiate from the middle portion of the lower rib to the edge of the upper margin, which may be crenulate or notched. These earstones are about 10·5mm. in length by about 7mm. in depth. The earstones of the smaller angler, the size of which has not been recorded, have the upper margin more regularly arcuate, while the lower want the angular outline of the larger otoliths. They measure about 5·5mm. by 3·5mm. The angler's earstones are small when compared with the length of the fish, those of the large specimen mentioned being only a little over one-ninetieth part of the entire length of the fish.

Fam. TRACHINIDÆ.

Genus *Trachinus*.

*Trachinus vipera*, Cuvier. The Lesser Weaver-fish. Pl. ii. B., figs. 8 and 9.

The earstones of the lesser weaver-fish are narrow and somewhat ovate in outline; both ends are pointed. Those represented by the figures on pl. ii. B. have thin surfaces slightly decorticated, so that the markings are obscure. The larger of the two fishes represented (fig. 8) measured 127mm. long (about 5 inches), and the earstones were fully 6mm. in length by 2·5mm. in depth; the smaller fish measured 119 mm., and its otoliths were slightly smaller than the others.

*Trachinus draco*, Linn. The Greater Weaver-fish. Pl. ii. B., fig. 10.

The specimen of *Trachinus draco*, from which the earstones represented by fig. 10 were obtained measured  $11\frac{3}{4}$  inches in length. The earstones, though somewhat similar in shape to those of the lesser weaver just described, were considerably larger, being at least 10mm. long by fully 4·5mm. in depth.

Fam. SCOMBRIDÆ.

Genus *Scomber*.

*Scomber scombrus*, Linn. The Mackerel. Pl. iii. B., fig. 36 ; pl. v., fig. 33.

The earstones of the mackerel are comparatively small. The one represented by figure 36 is from a fish of average size and about 3.5mm. in length. It has a general resemblance to the earstones of the herring, being narrow, with the sides parallel, the posterior end obtusely rounded and unequally bifurcated in front, the lower branch being produced into a narrow-pointed extremity.

Fam. GOBIIDÆ.

Genus *Gobius*.

*Gobius niger*, Linn. The Black Goby. Pl. ii. B., figs. 19 and 20; pl. v., fig. 6.

In this species the earstones are large in proportion to the size of the fish, and their broadly rhomboid form is so unlike that of the earstones of any of the other kinds of fishes examined that they appear to be characteristic of this particular species and to indicate that it might be possible to identify the fish almost entirely by the earstones.

The two fishes from which the earstones shown on Pl. ii. B. were obtained measured 105mm. in length, and their earstones are about 4mm. long by fully 3mm. in width. These earstones are thus about equal to one twenty-fifth part of the length of the fish.

*Gobius minutus*, Gmel. The Speckled Goby. Pl. ii. B., figs. 21-24.

The largest of the four fishes represented by the earstones shown on pl. ii. B., figs. 21 to 24, measured about 3 inches in length. The other three were smaller, the largest being 54 and the smallest 43mm. The earstones of the larger specimen were obscurely quadrangular in form and measured about 2.2mm. across the longest side, the width being slightly less. The earstones of the other specimens were very small, and resembled minute circular discs, the largest being little more than 1mm. in diameter.

Fam. CALLIONYMIDÆ.

Genus *Callionymus*.

*Callionymus lyra*, Linn. The Dragonet. Pl. iii. B., figs. 10-14; pl. v., figs. 10 and 11.

The earstones of the dragonet are very small, and they are subovate in outline; the lower margin is nearly straight, but the upper is boldly arcuate. The posterior end is rather blunt, but the anterior extremity ends in most of the specimens in a short point. In some of them it is slightly bifid, and the upper margin is also obscurely crenulated.

The earstones of five fishes of different sizes are shown on plate iii. B. The fishes measure 10 inches, 8½ inches, and 7¾ inches in length, while the length of other two (figs. 13 and 14) is doubtful. The earstones of the largest fish are about 3mm. long, which is equal to about one eighty-fourth part of the entire length of the fish. The earstones of the others are somewhat smaller and rather more pointed at the extremities.

*Callionymus maculatus*, Bonap. The Spotted Dragonet. Pl. iii. B., figs. 1-9; plate v., figs. 18 and 24.



Nine examples of this *Callionymus* have their earstones represented on pl. iii. B. The sizes of the fishes are, three at 150mm., one at 130mm., two at 112mm., one at 100mm., and two at 80mm. Their earstones closely resemble those of *Callionymus lyra* both in shape and size, except that in one or two of them the anterior end is rather more distinctly notched.

Fam. DISCOBOLI.

Genus *Cyclopterus*.

*Cyclopterus lumpus*, Linn. The Lumpsucker. Pl. iii. B., fig. 58; pl. v., fig. 15.

The earstones of the lumpsucker are exceedingly small when compared with the size of the fish. In an example  $15\frac{1}{2}$  inches long the earstones measure only 1.4mm. in length by about 1mm. in depth, or about one two-hundred-and-eightieth part of the length of the fish. They are subrotund in form, but one side is straight or nearly so, while the other is boldly arcuate or gibbous. Both ends are rounded, but one of them, where it joins the nearly straight lateral margin, is moderately angular, as shown by the enlarged photograph (fig. 15, pl. v.).

Fam. GOBIESCIDÆ.

Genus *Anarrhichas*.

*Anarrhichas lupus*, Linn. The Cat or Wolf-fish. Pl. iii. B., figs. 40-43; pl. v., fig. 21.

The earstones of the cat-fish are small in comparison with the size of the fish. Those of a specimen  $27\frac{1}{2}$  inches long measured about 4mm. in length by about 2.2mm. in depth, so that these earstones are only about the one hundred and seventy-fourth part of the length of the fish. They have a somewhat rugged appearance, resembling a rudely formed arrow-head, being broadest and thickest at the (?) posterior end, then tapering to a sharp point at the opposite extremity. The earstones of a fish 12 inches long did not differ greatly in shape from those of the larger example, but were considerably smaller, being only about 2.7mm. long by about 1.6mm. in depth (see fig. 43). They were proportionally rather larger than those of the larger fish, but small compared with those of the Gadoids. The earstones of other two examples of *Anarrhichas*,  $12\frac{1}{2}$  inches and  $13\frac{1}{2}$  inches in length, are represented by figures 42 and 41.

Fam. BLENNIIDÆ.

Genus *Pholis*.

*Pholis gunnellus*, Linn. The Butter-fish. Pl. iii. B., figs. 38 and 39.

The earstones of the butter-fish are also very small. They are of an oval shape, but neither in form nor sculpture is there anything very characteristic about them. Those obtained from a fish  $4\frac{1}{2}$  inches long measured about 1mm. by .6mm.

Genus *Enchelyopus*.

*Enchelyopus (Zoarces) viviparus*, Linn. Viviparous Blenny. Pl. iii. B., fig. 37; pl. v., fig. 31.

The viviparous blenny possesses earstones that somewhat resemble those of the mackerel in size as well as in form, but they appear to be rather larger in proportion to the size of the fish, and their upper margin is rather more boldly arcuate. A fish measuring 12 inches possessed earstones 4mm. in length by 2mm. in depth. They were thus about equal to one seventy-sixth part of the length of the fish.

Genus *Lumpenus*.

*Lumpenus lampretiformis*, Walb. Sharp-tailed Lumpenus. Pl. i. B., figs. 51–63; pl. iv., figs. 22, 23, and 26, 27.

The earstones of this species are small and oblong in shape. The upper margin is obscurely crenulated; the anterior end is slightly notched, or pointed, while the other is subtruncate or bluntly rounded. Those represented by the figs. 57 and 58 are from two fishes 295mm. long, and measure about 3mm. in extreme length by 2mm. in width. Another fish 176mm. long had earstones measuring 2.5 by 1.3mm. (see fig. 63, pl. i. B., and fig. 27, pl. iv.).

## Fam. Atherinidæ.

Genus *Atherina*.

*Atherina presbyter*, Cuvier. Sand Smelt. Pl. iii. B., figs. 34 and 35; pl. v., figs. 22 and 26.

The sand smelt has tolerably large earstones compared with the size of the fish. The larger of the two specimens examined, which measured about 5 inches in length, had earstones 4mm. long by 2.2mm. in depth, while those of the smaller fish, which was 3½ inches in length, measured 2.3mm. by 1.5mm. The earstones of the larger fish were equal in length to about the one thirty-second part of the entire length of the fish. Both margins are even and arcuate, one end is bluntly rounded, but the other, in the earstones of the larger fish, terminates in a sharp and slightly hooked process, and in those of the smaller the same extremity is bluntly pointed.

## Fam. Mugilidæ.

Genus *Mugil*.

*Mugil chelo*, Cuvier. The Thick-lipped Grey Mullet. Pl. iii. B., fig. 48; pl. v., fig. 12.

The earstones of the grey mullet are distinctly incurved and somewhat twisted, but this is not very clearly shown in the photograph. The lower margin is slightly thickened and nearly parallel with, but rather shorter than, the upper. The posterior end is abruptly truncated, the edge being crenulated, and in some examples deeply incised; the anterior extremity is obliquely truncated, the edge being thin and slightly irregular, while the angle is produced into a short tooth.

The fish from which the otoliths were obtained measured  $15\frac{1}{2}$  inches in length, and its earstones are 9mm. by 4.5mm.—they are thus equal in length to about the one forty-fourth part of the length of the fish.

Fam. LABRIDÆ.

Genus *Labrus*.

*Labrus bergylta*, Ascan. The Ballan Wrasse. Pl. ii. B, fig. 12-14; pl. v., fig. 8.

Three specimens of this *Labrus* have their earstones represented on pl. ii. B. They measured about 387mm., 330mm., and 254mm. respectively. The earstones are comparatively small—those of the larger fish (fig. 12) are about 5.4mm. in length by about 3mm. in depth. The length of these earstones is thus equal to about the one-seventieth part of the entire length of the fish. The specimen next in size had earstones slightly smaller (fig. 14), while the earstones of the third specimen (fig. 13) are a little over 4mm. long. The lower margin of the larger earstones is slightly arcuate and crenulated, especially the proximal half of it. The upper margin slopes upward in a nearly straight line from each end, so as to form an obtuse angle near the middle. The front end is deeply bifurcate, but the other terminates in a blunt point (see pl. v., fig. 8, which shows the otoliths greatly enlarged). The other earstones do not differ much from those described, except that the upper margin is not so distinctly angular.

*Labrus mixtus*, Linn. The Striped Wrasse. Pl. ii. B., fig. 15.

The earstones of this *Labrus* have a close resemblance to those of the ballan wrasse, and could scarcely be distinguished from them. Those represented by fig 15 were obtained from a fish  $11\frac{1}{4}$  inches in length, and measure fully 5mm. each.

*Labrus (Ctenolabrus) rupestris*, Linn. Jago's Goldsinny. Pl. ii. B., fig. 16.

This is a smaller species of *Labrus* than the others, and the earstones are proportionally small. The fish which is here represented by its earstones measured about  $4\frac{1}{4}$  inches in length (108mm.), and the size of its earstones is 3.2 by 1.6mm. They resemble those of the other species in their general character.

Fam. GADIDÆ.

Genus *Gadus*.

*Gadus callarias*, Linn. (syn, *Gadus morhua*, Linn.). The Codfish. Pl. i. A., figs. 1-10.

The otoliths of nearly all the species of *Gadus*, especially in those of adult size, are usually large, and massive in structure. One side is slightly concave and the other convex. The concave or exterior side is usually ornamented with ridges and furrows which are more regular and distinct in the otoliths of fishes that are young, or half-grown fishes. Those otoliths from codfish, particularly from examples 20 inches

long and upwards, differ in shape from the earstones of other species of *Gadus* in being distinctly wider at the anterior end, instead of having the upper and lower margins parallel or nearly so. The lower edge, which is longer than the upper, is only slightly convex, and in some cases nearly straight. A thick rib extends along the lower aspect of the convex or inner side, as indicated by the photographs (fig. 2), but the stones become thinner towards the upper edge. The upper edge is slightly convex and shorter than the lower. Anterior end obliquely truncated. Posterior end narrow, bluntly rounded, and terminating in a shallow depression. Upper and lower margins usually irregularly but distinctly crenulated. The pair of earstones represented on the plate by fig. 1 were removed from a codfish 40½ inches long; they measure about 21mm. in length by fully 10mm. in depth.\* Figure 2 on the same plate represents the earstones of another fish 36½ inches long, which measure about 18mm. by fully 9mm. Below I give in tabular form the sizes of the earstones of other fishes represented on pl. i. A.

Figures on Plate i. A.	Length of Fish.	Earstones.	
		Length.	Depth.
3	15 inches.	About 13·0mm.	Nearly 6·0mm.
4	27½ "	" 15·5mm.	7·5mm.
5	21 "	" 14·5mm.	About 6·5mm.
6	10 "	" 10·5mm.	" 4·0mm.
7	9 "	" 9·5mm.	" 3·7mm.
8	5½ "	" 6·5mm.	" 2·5mm.
9	4½ "	" 5·7mm.	" 2·3mm.
10	4½ "	" 5·3mm.	Fully 2·0mm.

*Gadus aeglefinus*, Linn. The Haddock. Pl. ii. A., figs. 1-5 and 9-16 ;  
pl. iv., figs. 1 and 2.

The earstones of tolerably large specimens of haddock have the upper margin nearly straight, and parallel with the lower margin ; the crenulation of this margin is not very strongly marked, but the lower margin, which is slightly convex, is distinctly crenated. Among the haddocks examined for the purposes of this paper, one was thin and emaciated, and its earstones were not only comparatively narrow and elongated, but they were also devoid to a considerable extent of the grooves and ridges so characteristic of earstones of the normal type ; this pair of earstones is represented by fig. 3., pl., ii. A.

A fairly large number of haddocks have been examined, and I find that most of those about 8 or 9 inches long have their earstones obliquely truncated in front, and that posteriorly the upper and lower margins converge, though somewhat unequally, to form a narrow, blunt pointed extremity. They are also laterally incurved, so that the hollow surface is toward the outside, the convex side being inside, as in those of the codfish. The earstones of the smaller haddocks are not so distinctly truncated in front, and the upper and lower margins are not parallel, but converge from the widest part near the anterior end gradually to the posterior extremity.

\* These earstones are thus equal to about the one forty-ninth part of the entire length of the fish. In the other example specially referred to they are about the one fifty-first part of its length. The earstones appear to be proportionally longer in the smaller fish.

The outer surface was more distinctly ornamented with small rounded ridges and furrows extending to both margins, producing a crenulated edge nearly all round. The largest fishes—4 in number—which are represented here by photographs of their earstones, range from  $17\frac{3}{4}$  inches to  $18\frac{1}{2}$  inches in length. The length of the earstones varied from a little over 16mm. to 18mm., and the variation in depth is slightly over 1mm. The annexed Table gives the sizes of the various fishes and of their earstones:—

Figure on the Plate.	Length of Fish.	Earstones.	
		Length.	Depth.
1 (Pl. ii. A.) ...	18 inches, ...	17·0mm. ...	6·2mm.
2 " ...	$18\frac{1}{2}$ " ...	17·3mm. ...	6·3mm.
3 " ...	$17\frac{3}{4}$ " ... { (Fish very emaciated.)	One 18·0mm. and one 18·5mm. }	About 5·6mm.
4 " ...	$17\frac{3}{4}$ " ... {	One 16·2mm. and one about 17mm. ... }	6·3mm.
5 " ...	$14\frac{3}{8}$ " ...	16·0mm. ...	*5·0mm. to 5·5mm.
9 " ...	$13\frac{1}{4}$ " ...	14·7mm. ...	Fully 5·0mm.
10 " ...	12 " ...	13·3mm. ...	4·5mm.
11 " ...	$10\frac{3}{8}$ " ...	11·5mm. ...	4·3mm.
12 " ...	$9\frac{1}{4}$ " ...	11·5mm. ...	4·3mm.
13 " ...	$8\frac{1}{4}$ " ...	11·2mm. ...	4·3mm. to 4·5mm.
14 " ...	$6\frac{1}{2}$ – $5\frac{1}{2}$ " ...	8·8·5mm. ...	About 3·0mm.
15 " ...			
+16 " ...			

It will be observed that the length of the haddock's earstones in proportion to the length of the fish is greater than in the case of the codfish. In the two largest haddocks referred to here the earstones are nearly equal to the one twenty-seventh part of the length of the fish, while in one example,  $8\frac{3}{4}$  inches in length, they reach to about one-twentieth part of the length of the fish.

*Gadus luscus*, Linn. The Brassie or Bib. Pl. ii. A., figs. 17–24; pl. iv., fig. 3.

The larger examples of the brassie possess earstones even more massive in structure than those of the haddock or codfish. The outer surface, which is distinctly incurved, is also more coarsely rugose, being ornamented with somewhat irregular and comparatively large rounded bosses, especially on the lower aspect of the exterior surface. These bosses, and to some extent the whole outer surface as well, have a polished and glassy appearance. The inner surface is convex and nearly smooth. The anterior end is obliquely truncated, and the anterior portion of the upper margin is nearly straight and parallel with the lower; then it gradually converges towards the lower edge till both meet in the moderately sharp-pointed posterior extremity. The massive structure of these otoliths is observable even in the smaller specimens. A brassie about 14 inches

\* Another haddock, 14 inches long, had massive earstones 16mm. in length by 6·5mm. in width. These are shown on pl. iv., fig. 2.

† The pair of earstones represented by fig. 16, pl. ii. A., are shown greatly enlarged on pl. iv., fig. 1, and the ridges and furrows on the outer surface are more clearly indicated in the figure.

long had very massive otoliths; they measured about 13.5mm. in length by 6.5mm. at the deepest part (these are represented by fig. 24). Those of a somewhat smaller fish were equally massive but rather shorter, measuring about 12.2mm. by 6mm. A number of other specimens of the same species have been examined, and measurements of six of them with the corresponding sizes of their earstones are given in the Table annexed.

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Depth.
17 (Pl. ii. A.)	89mm.	About 5.0mm.	2.5mm.
18     "	110mm.	" 6.0mm.	3.0mm.
19     "	162mm.	" 8.0mm.	Fully 4.0mm.
20     "	210mm.	" 10.5mm.	4.5mm.
21     "	11½ inches.	" 11.0mm.	5.3mm.
22     "	11½     "	" 11.4mm.	5.5mm.

In the larger examples of the brassies referred to here the proportion that the length of the earstones bears to the length of the fish is about the one twenty-sixth part, but it appears to become greater in the smaller fishes as in the case of the haddocks.

*Gadus minutus*, Linn. The Poor Cod.

This species is nearly allied to the last, and appears to possess somewhat similar earstones. No specimens are represented by the photographs.

*Gadus esmarkii*, Nilsson. The Norway Pout. Pl. ii. A., figs. 25-28.

Four specimens of *Gadus esmarkii* are represented by their earstones on pl. ii. A. They measured respectively 6½ inches, 5½ inches, 4½ inches, and 4 inches. Their earstones have a tolerably close resemblance to those of small *Gadus luscus*, but they are scarcely so massively formed, and are rather longer and narrower. Those removed from the largest specimen of *Gadus esmarkii* measured about 7.5mm. in length by fully 3mm. in depth, and those of the next three specimens measured about 6.5mm., 5.2mm., and 5mm. in length, and their depths varied in a corresponding degree. The earstones of the largest specimen were, as indicated by the foregoing measurements, about the one twenty-second part of the entire length of the fish.

*Gadus poutassou*, Risso. Couch's Whiting. Pl. ii. A., fig. 29; pl. iv., fig. 5.

This species is represented by a single pair of otoliths; they are from a fish 155mm. (fully 6 inches) in length, and measure 8.5mm. long by nearly 3mm. in depth. In their shape and sculpture they have a general resemblance to those of *Gadus esmarkii*, but are rather more slender and elongated. The anterior end is bluntly rounded, the upper and lower margins taper in a nearly uniform manner to the sharp-pointed distal extremity, and both margins are crenulated. The exterior side is only slightly incurved and moderately rugose, and the inner surface is nearly smooth.

*Gadus merlangus*, Linn. The Whiting. Pl. ii. A., figs. 6-8, 30 and 31.

The earstones of numerous whittings have been examined, and all, except those of very small specimens, agree in the peculiar form by which they may be distinguished from other species of *Gadus*. They are elongated and narrow. The lower margin is tolerably even and slightly convex. The anterior end is obliquely truncated, and with the edge usually crenulate. The upper margin, for about two-thirds of its length, from the anterior extremity, is nearly straight and parallel with the lower edge, then it gradually converges towards the lower margin, so that the posterior end is narrow and tapering and has a sharp-pointed termination. The earstones are somewhat concave outwardly, and slightly convex and nearly smooth on the inside. The lower edge is tolerably thick, while the upper, especially where it begins to taper towards the posterior end, is compressed and thin.

Photographs are given of the earstones of five whittings which measured respectively 14 inches, 12½ inches, 11¾ inches, 11¼ inches, and 9 inches in extreme length, and the size of their earstones given in the same order is as follows:—20mm. long by 5mm. in greatest width (fig. 30), 16mm. by about 4.5mm. (fig. 8), 16.5mm. by nearly 5mm. (fig. 7), 15mm. by about 4.7mm. (fig. 6), and 12.5mm. by about 4mm. (fig. 31). The earstones of two young whittings, about 68mm. (2¾ inches) in length, but which are not represented among those photographed, measured 3.5mm. by about 1.5mm., which is fully twice the length of those of a lumpsucker 15½ inches long.

By comparing the length of the earstones of a number of whiting of average size with the length of the fish they were taken from I found that, though the proportion varied to some extent, the length of the earstones approximated to about one-eighteenth part of the extreme length of the fish.

The proportion between the length of the earstones and of the fish they belong to varies considerably in the different kinds of fish. An examination of numerous examples of fish belonging to various species seems also to indicate that where the earstones are massive in structure, as in some of the Gadoids, they are shorter in proportion to the length of the fish than those that are thin and narrow. This may tend to explain why the earstones of the whiting are generally proportionally more elongated than those of the haddock or codfish.

*Gadus virens*, Linn. The Saithe or Coal-fish. Pl. i. A., figs. 14-16.

The earstones of large coal-fish are very massive in structure. Fig. 14 represents those of a fish of average size, but I am unable to state the exact length of the fish, though it could not be much under 36 inches. These earstones measure about 24mm. long by about 8mm. in greatest width. The upper and lower margins are tolerably straight and nearly parallel, and they are slightly crenulated along the edges. The front end is somewhat obliquely truncated, but at the posterior end the upper and lower margins converge so that they meet and terminate in a blunt point. They are also slightly twisted, and have the outer side incurved and slightly rugose, while the inner side is convex and nearly smooth.

Figs. 15 and 16 represent the earstones of two saithe about 15 inches long; they are narrow and elongated, and small when compared with those of the whiting. These earstones measure from 11mm. to about 11.5mm. in length, which is equal to about the one thirty-third part of

the length of the fish. This shows a somewhat marked difference from those of the whiting 14 inches long that measured 20mm. in length, or about the one-eighteenth part of the length of the fish.

*Gadus pollachius* (Cuv.). The Pollack or Lythe. Pl. i. A., figs. 11–13.

The lythe has earstones closely resembling those of the saithe in shape, in size, and sculpture. Fig. 11 represents the otoliths of a lythe 31 inches long; they measure about 20mm. in length by about 8mm. in greatest width. The length of these otoliths in proportion to the length of the fish is scarcely equal to half the length of those of the whiting referred to above, but what is wanting in length is made up by their more massive structure. Figs. 12 and 13 represent the earstones of two smaller fishes, but their lengths have not been recorded.

#### Genus *Merlucius*.

*Merlucius merluccius* (Linu.). The Hake. Pl. iii. A., figs. 32–35.

The earstones of the hake differ remarkably from those of other British Gadoids. They are thin and leaf-like, and are somewhat ovate in outline; they are broadest near the anterior end, and thence taper gradually backwards to the narrow distal extremity. The lower side has an evenly, but not very boldly, rounded edge that extends unbroken from the front to the posterior end. The upper edge is very thin and more or less finely serrated, the divisions between the serrations being in some parts very distinct; near the anterior end this margin rises into a prominent angle and forms the widest (or deepest) part of the earstone. Immediately posterior to this angle the margin is slightly concave, and this imparts to the angular prominence a somewhat gibbous appearance, as shown in the figure; from this point the margin slopes gradually to the distal end. The earstones of comparatively small fishes show the same gibbous appearance. The posterior end of the earstones is somewhat narrow and sharp-pointed. The fish from which the largest earstone, shown on pl. iii. A. (fig. 33), was taken was a tolerably large one, but its length was not recorded. This earstone measures about 27·5mm. long by fully 9mm. in greatest width. The next largest of the otoliths represented by the figures were from a rather smaller fish than the one just referred to, but its length has also not been recorded. These otoliths are about 25mm. in length, and their greatest width nearly 9mm. Two otoliths from a hake 16 inches long (fig. 34) measure nearly 17mm. by about 6mm., and another fish 14½ inches long was furnished with earstones 16mm. in length by about 5·5mm. in greatest depth. In these last two examples the length of the earstones is equal to one twenty-fourth and one twenty-third part of the entire length of the fishes they were taken from.

#### Genus *Phycis*.

*Phycis blennoides* (Brün.). The Greater Forkbeard. Pl. i. A., fig. 27.

The earstones from a moderately large specimen of the greater forkbeard are represented by fig. 27 on pl. i. A. This fish, the size of which was not recorded, possessed tolerably large earstones. They measure about 16·5mm. in length by 6·5mm. in depth. The upper margin, which is nearly straight, has the edge moderately sharp and irregularly serrate, while the anterior extremity is obliquely truncated. The lower margin is boldly arched and somewhat angular in the middle, and converges



posteriorly towards the upper margin more than it does forward, and the posterior end is therefore moderately narrow and is also bluntly rounded, as shown by the photograph. The earstones are slightly concave outwardly and considerably thickened towards the anterior end, especially on the lower aspect.

Genus *Molva*.

*Molva molva* (Linn.). The Ling. Pl. i. A., figs. 19-26.

The earstones represented by fig. 19 were obtained from a medium-sized ling, but the exact length of the fish was not stated. These earstones have a general resemblance to those of the coal-fish and lythe. The anterior end, however, is not angular but forms a bold curve, which merges into the upper margin. This margin is only slightly arched in the middle part, then slopes posteriorly to the sub-central and narrow rounded distal extremity; lower margin nearly straight except near the posterior end, where it converges to meet the upper margin. The otoliths are about 20mm. in length by about 8mm. in their greatest width. The earstones of young ling apparently differ to some extent from those of larger fish in their form and structure. Fig. 22 represents the earstones of a fish 22½ inches long, and though the general contour is similar to the larger otoliths, the upper margin is not regular. These earstones measure only about 9mm. in length. Fig. 23 represents the earstones obtained from a ling about 10½ inches long, and which measure fully 5·5mm. Figs. 24 to 26 represent the earstones of smaller specimens of ling ranging from 8½ inches to 7 inches in extreme length.

Genus *Onos*.

*Onos tricirratus* (Brün.). The Three-Bearded Rockling. Pl. i. B., figs. 9-12; pl. iv., fig. 18.

The three-bearded rocklings possess earstones that are narrow and elongated; the upper and lower margins are nearly parallel, and when viewed from the side are seen to be slightly sigmoid in outline and somewhat twisted. Those represented by fig. 11 were obtained from a fish 15 inches long, and measure nearly 8mm. in length—equal to about the one twenty-sixth part of the entire length of the fish—and they are about 4 times longer than broad. These earstones appear, however, to vary a good deal in length, for those taken from another fish only a little shorter than the one just referred to measured about 6·2mm., but the width is about the same as that of the other. It was also observed that the otoliths of small fishes did not possess the sigmoid outline that characterises the adult examples. Two specimens 11½ inches and 8 inches long respectively had earstones measuring 4·5mm. and 3·5mm.—the last wanted the sigmoid appearance already referred to (*see* figs. 10 and 9).

*Onos cimbrius* (Linn.). The Four-Bearded Rockling. Pl. i. B., figs. 13-17; pl. iv., fig. 10-11.

This species possesses earstones quite distinct from those of the three-bearded rockling; their outline is obscurely triangular, two sides being nearly equal and shorter than the third side, and this difference is noticeable in the earstones of even small examples. Those represented by fig. 13 were removed from the ear-chambers of one of the largest of the fishes examined. This fish measured 260mm. (fully 10 inches), while the extreme length of the earstones was only 5·0mm. and the greatest width 2·5mm. These earstones are thus only about the one-fiftieth part of the

entire length of the fish. The annexed table contains the measurements of a few of the other fishes examined and of the sizes of their otoliths.

Figure on the plate. (i. B.)	Length of the fish.	Earstones.	
		Length.	Depth.
14	220mm.	3·7mm.	2·0mm.
15	185mm.	3·1mm.	1·7mm.
16	177mm.	3·1mm.	1·7mm.
17	165mm.	3·1mm.	1·7mm.

The earstones of the three smallest fishes are almost identical in size and shape.

Genus *Raniceps*.

*Raniceps raninus* (Linn.). The Lesser Fork-beard. Pl. i. B., figs. 1-8 ; pl. iv., fig. 6.

The earstones of the lesser fork-beard or tadpole fish are tolerably large; their outline forms a nearly regular oval; both the lower and upper margins are moderately thin and convex, and converge towards both ends which are narrow and rounded, but the posterior extremity is more pointed than the other. A thickened but obscurely defined rib extends along the middle line from end to end, and gives a massive appearance to the otolith. The largest fish represented here was 12 inches long, and its earstones measured—one, fully 14mm., the other 15mm. in length and about 7mm. in greatest width, so that in this example the length of the earstones is equal to about the one twenty-second part of the entire length of the fish.

Fig. 5 represents the earstones of a fish about 8½ inches long, and as they measure about 11mm. in length they show almost the same proportion to the length of the fish as the other—viz., about one-twentieth part. Fig. 7 represents the earstones of another fish that measured about 180mm., and as the earstones are nearly 10mm. in length, it seems to bear out what has been already stated, that in some species and within certain limits the smaller fishes possess earstones relatively larger in proportion to the length of the fish than the adult specimens. The annexed Table gives the length of a number of the fishes examined, with the sizes of their otoliths:—

Figure on the Plate. (i. B.)	Length of the Fish.	Earstones.	
		Length.	Depth.
1 ...	12 inches, ... {	1 fully 14 and 1 nearly 15mm. }	7·0mm.
2 ..	10½ " ... {	Average of the two, 12·5mm. }	6·0mm.
3 ..	9½ " ...	12·3mm. ...	5·5mm.
4 ...	9½ " ...	12·0mm. ...	5·3mm.
5 ...	8½ " ...	11·2mm. ...	4·5mm.
6 ...	7½ " ...	10·7mm. ...	4·5mm.
7 ...	7½ " ...	9·8mm. ...	4·5mm.
8 ...	4 " ...	2·4mm. ...	1·0mm.

The last example had earstones so small as to be greatly out of proportion to the length of the fish when compared with the others in the series. I mention the fact in order that further attention may be drawn to it.

Fam. OPHIDIIDÆ.

Genus *Ammodytes*.

*Ammodytes tobianus*, Liun. The Lesser Sand-eel. Pl. i. B., figs. 64 and 65.

The earstones of the sand-eels are very small, and their general outline is oval, but somewhat narrow and pointed at the posterior end. The earstones represented by fig. 64 were obtained from a fish 7 inches long, and they measured 3.5mm. by about 1.6mm., while those represented by fig. 65 are only about 2.5mm. by 1.0mm., and were obtained from a fish 125mm. (5 inches) in length.

Fam. PLEURONECTIDÆ.

Genus *Hippoglossus*.

*Hippoglossus vulgaris*, Flem. The Halibut. Pl. iii. A., figs. 1-6 and 14.

The earstones represented by fig. 1 are those of a halibut that weighed 179 lbs. (or within 2 lbs. of 13 stone). The fish was captured in 1884, when I obtained the head of it for examination; the length of the fish was not recorded. The otoliths measure from 17mm. to 18mm. in length by about 11mm. in width, but the two differ slightly in size. Those represented by fig. 14 were removed from a small halibut about 18½ inches long, and these otoliths measure about 8.5mm. in length by about 5mm. in depth. In this example the length of the earstones is only equal to about one fifty-fourth part of the entire length of the fish. The earstones represented by figs. 3 and 4 are from two fishes that are each about 11½ inches in length, and they measure 6mm. by about 3.5mm., while those represented by figs. 4 and 5 are from fishes measuring respectively 260mm. and 220mm. in length.

In this species, as in most of the Pleuronectidæ, the earstones are flat and moderately thin. Those of the large halibut mentioned above have a somewhat irregular outline; on one side the margin is nearly straight, while the margin opposite is somewhat convex, and exhibits in one of the otoliths a distinctly crenulated edge. One end is obliquely truncate, but in the case of one of the stones the other end has a wide shallow notch, while the other otolith is furnished with a hook-like process. The earstones of the smaller fishes are ovate, and have a rather more regular outline; the posterior end is somewhat truncated, but the anterior end is narrow and rounded.

Genus *Drepanopsetta*.

*Drepanopsetta platessoides* (Fabr.). Long Rough Dab. Pl. iii. A., figs. 7-13.

In this species the earstones of the larger fishes are broadly ovate, the length being only about one-third more than the greatest width. The upper margin is distinctly arched, but the lower is only slightly and irre-

gularly convex. One end is subtruncate, but the other is broadly rounded. The earstones of a considerable number of long rough dabs have been examined, and it has been noticed that though the larger examples retained their characteristic shape there was some variation in the proportion of their sizes to the length of fishes they belonged to. The two largest of the fishes among the number selected for this paper measured respectively 370mm. and 317mm. in length, their earstones—represented by figs. 7 and 8—are almost identical in size, and measured about 7.5mm. and 5mm. in length and width. It has been observed that the length of the earstones of most of the Pleuronectids examined are shorter in proportion to the length of the fish than those of the more typical Gadoids. The earstones of the two fishes mentioned above averaged, roughly, about the one forty-fifth or forty-sixth part of the average length of the fishes. It has also been noticed that where there is an increase in the width of the otoliths there is to some extent a corresponding decrease in the length.

In the annexed Table the length of other five examples of long rough dabs are given, with the lengths of their earstones:—

Figure on the Plate. (iii. A.)	Length of the Fish.	Earstones.	
		Length.	Depth.
9	10 inches.	About 6.5mm.	{ One 4.5mm. and one 5.0mm. About 3.8mm. " 3.5mm. " 2.5mm. " 2.0mm.
10	8 "	" 5.3mm.	
11	7 "	" 4.8mm.	
12	5 "	Fully 3.0mm.	
13	3½ "	About 2.5mm.	

The earstones of the smaller fishes become more and more rotundate as the length of the fishes decrease.

#### Genus *Bothus*.

*Bothus maximus* (Linn.). The Turbot. Pl. i. B., fig. 33.

The earstones represented by fig. 33 were from a turbot of about the average size (about 20 inches in length). One of them, which is barely 6mm. over all, in its general outline is very like one of those of the large halibut already referred to (fig. 1, pl. iii. A.), but much smaller, and it is fully 4mm. in width; the other earstone, which is nearly of the same length as the first, but about 4.5mm. in depth (or width), has a somewhat different form, and differs also in having the entire margin distinctly crenulated. This difference between these two earstones may be only accidental, but the otoliths of another fish to be presently described show that such variation may be normal. Whether it be so in the present case, however, can only be ascertained by the examination of several specimens of different sizes, but not the very young, where variations of this kind tend to disappear.

The earstones of the brill, *Bothus rhombus*, are not represented among the specimens photographed, but they appear to resemble those of the turbot.

Genus *Zeugopterus*.

*Zeugopterus punctatus* (Bloch). Müller's Topknot. Pl. i. B., figs. 42 and 43.

The earstones represented by the figures 42 and 43 are from two fishes, one of them being  $8\frac{1}{2}$  inches and the other  $5\frac{1}{2}$  inches in length. These earstones are small and somewhat oval in shape, but deeply notched and truncate in front. One side, the inner one, is slightly convex and is longitudinally grooved, but the reverse side is smooth. Those of the larger fish are nearly 4mm. long by 2.5mm. in greatest width; those of the other fish are 3mm. in length, and rather wider than the larger one.

Genus *Lepidorhombus*.

*Lepidorhombus Whiff* (Walb.). Sail Fluke, Whiff, or Megrim. Pl. i. B., figs. 31 and 32; pl. ii. B., figs. 1-5; pl. v., figs. 1 and 2.

The earstones of a megrim about 17 inches long are represented by fig. 1, pl. ii. B., and fig. 2, pl. v., and they measure about 7mm. in length by nearly 5mm. in greatest width. The length of these earstones is thus about the one-sixtieth part of the entire length of the fish.

In the megrim, as has been already stated, the earstone on the left side differs somewhat in shape from the one on the right side, and this difference is observable even in the earstones of the smaller fishes, but perhaps not in very young specimens; I find that in such specimens the characteristics peculiar to the species or genus are usually obscure or undeveloped. This will be more readily perceived by comparing the photographs of the earstones of the larger megrim mentioned above with those of the two smaller fishes represented by figs. 31 and 32, pl. i. B., and which measure respectively 168mm. and 87mm. in length. Compare also with the earstones represented by fig. 5, pl. ii. B., which are those of a fish 11 inches in length.

In the examination of large fishes or of those of moderate size the difference in the shape of the earstones is readily noticed, one of them being pear-shaped—that is, broadly truncated and somewhat emarginate at the posterior end, with the lateral margins boldly rounded and converging towards the narrow anterior extremity; the lower edge is tolerably even, but the other is scarcely so regular. The curve of the two sides is slightly different, and this makes the anterior extremity appear as if it were turned somewhat upward. Each earstone is also slightly incurved on the outer aspects, the inner being correspondingly convex.

The other earstone, like the last, is also widest posteriorly, but the posterior end is obliquely truncated and deeply, and sometimes irregularly, notched. The entire lower edge is boldly curved and tolerably even, but the upper margin, though it has the posterior portion nearly straight or slightly rounded, and more or less distinctly crenulated, is towards the front end interrupted by a considerable break in its continuity; this break appears to be more distinct in the earstones of larger fishes, and the presence of this break causes the anterior extremity to terminate in a tolerably sharp point.

I have already given the size of the earstones of the largest fish examined, and the sizes of a few of the others will be found in the annexed Table.

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Width.
2 (Pl. ii. B.)	16½ inches.	About 6·5mm.	4·5mm.
3 „	14 „	„ 5·3mm.	4·0mm.
4 „	12 „	„ 5·0mm.	3·5mm.
5 „	11 „	„ 5·0mm.	One 3·5mm., other rather less.
32 (Pl. i. B.)	165·0mm.	„ 3·6mm.	
33 „	87·0mm.	„ 2·0mm.	1·5mm.

It will be noticed that while in the case of the first four the earstones are only about one-sixtieth or sixty-fourth part of the length of the fishes they belonged to, the earstones of the smaller fishes are proportionally larger, as in some other examples previously mentioned.

#### Genus *Platophrys*.

*Platophrys laterna* (Walb.). The Scald-fish. Pl. i. B., fig. 30.

The earstones of a single example of the scald-fish are represented here. They are from a fish measuring 138mm. (about 5½ inches) in length, and are of an oblong form. The posterior end is truncated, and there is a small notch at the anterior extremity. They measure about 3mm. long by about 2mm. in width.

#### Genus *Pleuronectes*.

*Pleuronectes platessa* (Linn.). The Plaice. Pl. iii. A., figs. 15–21.

The earstones of seven examples of plaice, the length of which ranges from 610mm. (about 24 inches) to 64mm., are shown on pl. iii. A. The large pair have a tolerably massive structure, and are of an oval shape; the posterior end is moderately broad and somewhat obliquely truncated, while the anterior end is tolerably narrow and rounded; the lower margin is evenly, but not very boldly, rounded or much thickened. The upper edge, which is thicker than the other, is moderately straight but of a somewhat irregular outline, and exhibits a shallow notch near the middle. They measure about 12mm. long by about 7·5mm. broad. They are thus about one-fiftieth part of the entire length of the fish. The other earstones represented by the photographs are from comparatively small fishes, the lengths of which, and of their earstones, are given in the annexed Table.

Figure on the Plate. (iii. A.)	Length of the Fish.	Earstones.	
		Length.	Width.
16	287mm.	About 6·5mm.	Nearly 4·5mm.
17	273mm.	„ 6·2mm.	About 4·5mm.
18	273mm.	„ 6·0mm.	„ 4·0mm.
19	160mm.	„ 4·0mm.	„ 2·8mm.
20	91mm.	„ 2·5mm.	„ 2·0mm.
21	64mm.	„ 2·0mm.	„ 1·5mm.

The earstones of two other plaice, each about 456mm. long (not represented among the photographs), measured fully 6·5mm. in length by about 5·5mm. at their greatest width, and 9mm. by nearly 6mm., and thus agreeing fairly well with the others in their proportion to the length of the fishes they belonged to.

On comparing the earstones of the smaller halibut with those of the larger specimens of long rough dabs and plaice, a certain similarity may be traced both in the general form of the otoliths and of their markings as well as in the proportion of the length to the depth (or width). It will be seen that they are all broadly oval in outline, their lower edge is evenly rounded, and the widest part of the otolith is apparently at the posterior end. The earstones of *Pleuronectes flesus* and *Pleuronectes limanda*, and of one or two others, are also somewhat similar in form to those referred to. There is, however, at least one notable exception in the Genus *Pleuronectes*, *P. cynoglossus*, or the Witch Sole, to be referred to presently, the earstones of which are nearly circular in outline instead of being oval.

*Pleuronectes microcephalus*, Don. The Lemon Dab. Pl. i. B., figs. 19-25.

The earstones of the lemon dab are comparatively small and are not very distinctly characterised. Fig. 19 represents those of a fish 15 inches long, and they only measure a little over 4mm. by about 2·5mm. To show how small these earstones are it is only necessary to mention that those of a long rough dab scarcely as large as this species had earstones nearly double their length, while the earstones of a plaice that was at least 4 inches shorter were one and a half times as long. In the annexed Table the sizes of several other lemon dabs are given whose earstones are represented by photographs on the accompanying plates.

Figure on the Plate. (i. B.)	Size of the Fish.	Earstones.	
		Length.	Depth.
20	12 inches.	3·5mm.	2·0mm.
21	7½ "	3·0mm.	1·5mm.
22	6½ "	2·8mm.	1·5mm.
23	5½ "	2·5mm.	1·3mm.
24	4½ "	2·0mm.	1·0mm. fully.
25	3½ "	1·7mm.	1·0mm.

The earstones represented by fig. 20 have the upper and lower margins nearly parallel, one end is obliquely truncated, but the other is pointed; in the smaller specimens both ends are rounded, and they are all proportionally smaller than those of the plaice or the long rough dab.

*Pleuronectes flesus*, Linn. The Flounder or Fluke. Pl. i. B., fig. 18.

The earstones represented by fig. 18 were obtained from a fish of average size, but its exact length was not recorded, and they are the only examples included among the photographs of the present series. They have an outline somewhat resembling the earstones of the plaice, and measure about 6·5mm. in length by fully 4·5mm. at the widest part.

They are broadly ovate, and the margins are obscurely crenulated; they are also moderately thin, and at the time they were removed from the fish the concentric growth-lines were very distinct.

*Pleuronectes limanda*, Linn. The Dab. Pl. ii. B., figs. 28 and 29; pl. iii. A., figs. 27-31.

The earstones represented by figs. 27 and 28, pl. iii. A., are from dabs of moderate size (8 to 9 inches long), but their exact length was not recorded. They have a tolerable resemblance to the earstones of young halibut, represented by figs. 2 to 5 on the same plate (pl. iii. A.). They measure about 5mm. in length by about 3mm. in depth. Figs. 29 to 30 represent the earstones of fishes measuring  $7\frac{3}{4}$  inches,  $5\frac{3}{4}$  inches, and  $4\frac{1}{2}$  inches long, while the earstones themselves measure about 4.5mm., 3.5mm., and 3mm. respectively, their width being about two-thirds of the length.

*Pleuronectes cynoglossus*, Linn. The Witch Sole. Pl. i. B., figs. 26-29; pl. iii. A., figs. 22-26; pl. iv., fig. 30.

The witch sole has earstones which differ very distinctly in shape from all the other species of *Pleuronectes* referred to here. They are large in proportion to the size of the fish, very flat, and nearly circular in outline, and it is in this latter respect that they differ so distinctly from the other species.

The largest of the witch soles mentioned here measured 16 inches in length, and its earstones (pl. iii. A., fig. 22) were fully 8mm. across their longest diameter by about 7.5mm. across the narrowest part. The lower margin is nearly straight, but otherwise the outline is almost circular. The longest diameter of these earstones is about one-fiftieth part of the entire length of the fish. The other specimens whose earstones are represented here were of various sizes, and all of them smaller than the one referred to above. The length of the different specimens and the size of their earstones are given in the annexed Table.

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Width.
26 (pl. i. B.)	170mm.	3.5mm.	3.5mm.
27 "	165mm.	3.5mm.	3.2mm.
28 "	160mm.	3.5mm.	3.3mm.
29 "	153mm.	3.2mm.	3.0mm. fully.
23 (pl. iii. A.)	12 inches.	5.5mm.	5.0mm.
24 "	$11\frac{1}{2}$ "	{ One 5.5mm. and one 5.0mm.	One 5.0mm. and
25 "	$10\frac{1}{2}$ "		one 4.7mm.
26 "	$9\frac{1}{2}$ "	5.0mm.	4.5mm.
		4.3mm.	4.2mm.

It will be observed that the earstones represented by fig. 26 (pl. iii. A.) have about the same proportion to the length of the fish as that of the larger examples specially referred to, while a slight variation is observable in the length of the earstones of the smaller fishes.



Genus *Solea*.

*Solea vulgaris*, Quensel. The Black Sole. Pl. i. B., fig. 34; pl. iv., fig. 17.

A single pair of earstones are represented among the photographs given here. They are from a fish of scarcely average size, its entire length being only 12½ inches, but they represent the characteristic form and size of the earstones of *Solea vulgaris*. The earstones of this specimen were 5mm. across the longer diameter, by fully 4mm. in width, so that they are equal to about one sixty-third part of the entire length of the fish. A smaller specimen, whose earstones are not represented on the plate, measured about 240mm., and its otoliths about 3·5mm. by 3mm. fully. The earstones of this specimen were therefore only about the one sixty-ninth part of the length of the fish.

These earstones have an obscurely quadrilateral outline, a side and an end being nearly at right angles with each other. The remaining side and end are slightly arched, as shown in the figure. The earstones of the smaller fish just mentioned have also an outline similar to that described.

*Solea variegata*, Don. The variegated Sole or Thickback. Pl. i. B., figs. 35 and 36; pl. iv., figs. 28 and 29.

The earstones of two specimens of this species of sole, nearly of the same size, are shown on pl. i. B., and by figures considerably enlarged on pl. iv. The specimens measured respectively 140mm. and 137mm. in length. Their earstones are flat, almost circular, disks measuring about 3mm. across the longer, by nearly 2·5mm. across the shorter diameter. The size of these earstones in proportion to the length of the fish is therefore greater than that of the black soles mentioned above.

*Solea lutea*, Risso. The Solenette. Pl. i. B., fig. 37-41; pl. iv., figs. 24 and 25.

A number of solenettes have been examined for their earstones, and a few of them are represented among the photographs. These earstones are very small and have little to characterise them except that they are flat, and nearly circular in outline. The size of the different fishes and of their earstones are given in the annexed Table.

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Width.
37 (pl. i. B.; pl. iv., fig. 24).	117mm.	3·0mm.	2·2mm.
38 (pl. i. B.; pl. iv., fig. 25).		2·0mm.	1·5mm.
39 (pl. i. B.)	90mm.	About 2·0mm.	1·5mm.
40 „	76mm.	1·7mm.	1·5mm.
41 „	64mm.	1·5mm.	1·5mm.

## Fam. SALMONIDÆ.

Genus *Salmo*.

*Salmo salar*, Linn. The Salmon. Pl. ii. B., fig. 31; pl. v., fig. 9.

The earstone represented by fig. 31., pl. ii. B., measures about 7mm. in length and about 3.6mm. in depth. The length of the fish they were obtained from has not been recorded; I may mention, however, that those represented by fig. 9 on pl. v. are from a salmon weighing about 10 lbs., but, as in the previous example, the length of this fish was not stated. The earstones are of an oval form, with both ends moderately narrow and bluntly pointed, but one end is more drawn out than the other, as shown in fig. 9.

*Salmo (?) fario*, Linn. The Brown Trout. Pl. ii. B., fig. 30.

The earstones represented on pl. ii. B. are from a trout weighing three quarters of a pound, which was caught in Loch Thom, near Greenock, many years ago.

Genus *Coregonus*.

*Coregonus lavaretus*, Penn. The Powan (or Pollan). Pl. ii. B., figs. 25-27; pl. v., fig. 29.

The earstones represented on pl. ii. B. are from Loch Lomond powans measuring  $8\frac{1}{2}$  inches, 8 inches, and  $7\frac{1}{2}$  inches in length. Those from the first two fishes are nearly of the same size—viz., about 5.5mm. long by 3mm. in greatest width, one of the ends—(?) the anterior—is moderately broad and has a rounded margin, but the other end is pointed; the lower margin is tolerably even, while the upper, which anteriorly is nearly parallel with the lower, slopes from about the middle to the pointed extremity at the posterior end. The earstones of the smaller fish measure about 5mm. in length and 2.5mm. in depth, and these have the posterior end rather more pointed than in the others.

Genus *Argentina*.

*Argentina sphyræna*, Linn. The Hebridean Smelt. Pl. i. B., figs. 44 and 45; pl. iv., fig. 9.

The Hebridean smelt is one of a small number of fishes that possess earstones of a shape so unlike those of other fishes that there can be little difficulty in determining the species the fish belongs to by the earstones alone. The earstones of two specimens are represented by the photographs—figs. 44 and 45, pl. i. B. Fig. 9, pl. iv., gives a greatly enlarged representation of those in fig. 44. The fishes from which these earstones were obtained measured  $8\frac{1}{2}$  inches and 8 inches respectively, while the earstones themselves measured about 3.5mm. in extreme length and depth—the length and depth being about equal. These earstones, which differ in form from those of the other fishes mentioned in this paper, may be described as broadly scaphoid or boat-shaped, the short lower margin representing the keel, and the longer upper margin with its two small prominences being the deck, while the obliquely truncated anterior end represents the bow, and the other and nearly rectangular end the stern. The extreme length of these earstones is rather more than the one-sixtieth part of the length of the fish.

## Fam. ESOCIDÆ.

Genus *Esoc*.

*Esoc lucius*, Linn. The Fresh-water Pike. Pl. iii. B., fig. 60; pl. v., fig. 20.

The fresh-water pike from which the earstones represented on pl. iii. B. were obtained was of moderate size, but its length has not been recorded. There were three otoliths of moderate size in each ear-chamber, and one or two smaller ones. The largest stones measured about 9mm. in length by 5mm. in greatest width. They are very irregular in outline, especially along the upper margin and round the (?) anterior end. The lower margin is tolerably even and slightly arcuate; the anterior end is broad and deeply notched, and the anterior portion of the upper margin, which is nearly straight, is separated from the posterior portion by an abrupt break in its continuity—this latter portion being narrow, and tapering gradually to the pointed distal extremity. One of the other two stones is narrow and elongated, and fully 4.5mm. in length; the third stone is small and subtriangular in outline, as shown in the photograph.

## Fam. CYPRINIDÆ.

Genus *Leuciscus*.

*Leuciscus rutilus* (Linn.). The Roach or Braise. Pl. iii. B., fig. 59; pl. v., fig. 5.

The earstones represented by fig. 59, pl. iii. B., are from a roach about  $5\frac{1}{2}$  to 6 inches in length. They are somewhat reniform in general outline, and the surface is ornamented with radiating grooves which terminate in the irregularly crenulated or jagged margins. They are about mm. across the widest part by about 3mm. in depth. The peculiar form and structure of these earstones are more obvious in the enlarged photographs on pl. v., fig. 5. They do not resemble any of the others described in this paper.

## Fam. CLUPEIDÆ.

Genus *Clupea*.

*Clupea harengus*, Linn. The Herring. Pl. iii. B., figs. 15-24; pl. v., figs. 3 and 4.

The earstones of a series of ten herrings of different sizes are represented on pl. iii. B. The largest of the series (fig. 15) measured  $12\frac{3}{8}$  inches (about 314mm.) in length, and the smallest (fig. 24) about 125mm. In these earstones the lower margin, which is only slightly arcuate, is obscurely crenulated along the edge, but is otherwise unbroken; the upper margin is nearly straight and parallel with the lower, but its continuity is interrupted by a distinct break near the middle, and in consequence of this break the anterior half of the earstone is very narrow, and only about half the width of the posterior portion. The posterior end is

broadly rounded, and the posterior portion of the upper margin is also crenulated. The sizes of the various specimens referred to and of their earstones are given in the annexed Table:—

Figure on the Plate.	Length of the Fish.	Earstones.	
		Length.	Depth.
15 (Pl. iii. B.)	314mm.	Not quite 4·5mm.*	Fully 2·0mm.
16 "	292mm.	About 5·0mm.	" 2·0mm.
17 "	279mm.	" 4·5mm.	" 2·0mm.
18 "	266mm.	Nearly 5·0mm.	About 2·0mm.
19 "	235mm.	Fully 5·0mm.	Nearly 2·5mm.
20 "	230mm.	" 5·0mm.	" 2·5mm.
21 "	215mm.	" 3·5mm.	Scarcely 2·0mm.
22 "	205mm.	About 3·5mm.	Fully 1·5mm.
23 "	186mm.	" 2·7mm.	About 1·5mm.
24 "	125mm.	" 2·0mm.	Fully 1·0mm.

The comparative sizes of the earstones of the herrings given here varied to some extent, ranging from about the fiftieth to the sixtieth part of the length of the fish they belonged to.

*Clupea sprattus*, Linn. The Sprat. Pl. iii. B., figs. 25–32; pl. v., figs. 15–17.

The earstones of the sprat are extremely small, and easily missed. They resemble those of the herring to some extent, but are comparatively shorter and broader, and even very small specimens exhibit this characteristic difference. The earstones of the largest of the sprats examined for this paper, and which measured about  $3\frac{3}{4}$  inches in length, were only about 1·5mm. in extreme length by 1mm. in depth. Other two sprats,  $3\frac{1}{2}$  inches long, showed scarcely any difference in the size of their earstones from that of the specimen just referred to (*see* figs. 27 and 28). The position of these otoliths in the ear chamber is similar to that of the herring—that is, the narrow part of the earstone is towards the front of the head, and the upper margin is more irregular in outline than the lower. The earstones represented by fig. 29 are from a fish  $3\frac{5}{8}$  inches (84mm.) long, and are about 1mm. in length by 0·7mm. in depth. The otoliths represented by figs. 30 to 32 are from sprats measuring 72mm., 67mm., and 60mm. long.

*Clupea pilchardus*, Bloch. The Pilchard. Pl. iii. B., fig. 33; pl. v., fig. 32.

The earstones of the pilchard, as will be seen from the photograph, are somewhat similar to those of the herring, both in form and size, except that they are rather more pointed at the anterior end. The fish from which these earstones was obtained was  $6\frac{3}{4}$  inches (171mm.) in length, and the earstones themselves measured 3mm. by about 1·2mm.

\*The earstones of this specimen were imperfect.

## Fam. MURÆNIDÆ.

Genus *Anguilla*.

*Anguilla vulgaris*, Leach. The Eel. Pl. i. B., figs. 67-69; pl. v., fig. 25.

The largest specimen of the eels whose earstones are represented here measured about 24 inches in length, and the other two 16 inches and 12½ inches respectively; their earstones are very small, those from the largest fish are only about 3.5mm. long by 2mm. in depth. Those belonging to the fish next in size (16 inches) measured fully 2.5mm. by 1.7mm., while those of the smallest specimen (12½ inches) measured 2mm. by 1.5mm. The earstones of the largest of the three fishes are only about one-seventieth part of the entire length of the fish; they are thus smaller in proportion to the length of the fish than most of the others described here.

Genus *Conger*.

*Conger niger*, Risso. The Conger. Pl. i. B., fig. 66; pl. iv., fig. 14; pl. v. fig. 7.

Among the earstones represented here are those of two specimens of conger—one 28½ inches in length, the other 54 inches. The first are represented by fig. 66, pl. i. B., an enlarged photograph of which is shown by fig. 14, pl. iv.; while those of the larger fish are represented by fig. 7, pl. v. The smaller earstones are nearly 9mm. long by about 3.5mm. in depth, but the length of the larger specimens was 11.5mm.; they are thus equal to about the one hundred and twenty-third part of the entire length of the fish. The earstones of the smaller fish are moderately thin and of a narrow oval outline, being widest near the middle and with one end narrowly rounded and the other narrow and angular. Those of the larger fish are tolerably massive, the sides are nearly parallel but somewhat sinuous in outline, and the ends, like those of the smaller fish, are one of them bluntly rounded, while the other is angular. The surface of the earstones does not appear to be ornamented with any regular markings except one or two shallow longitudinal ridges.

## Fam. SYNGNATHIDÆ.

Genus *Nerophis*.

*Nerophis lumbriciformis*, Will. The Worm Pipe-fish.

The earstones of a specimen of this pipe-fish have been in my collection for many years (since March 19, 1885—the date when the fish was captured at Lunderston Bay, Firth of Clyde). They are so exceedingly small that they have not been photographed with the others represented here. They are compressed, and resemble circular disks, except that one end is slightly notched, the notch being a little on one side of the middle line. They are somewhat like certain small Foraminifera, such, for example, as *Biloculina depressa*, but more diminutive. Their true form can only be made out satisfactorily under the microscope, with a 1-inch objective. They measure across their longest diameter about .26mm. (about  $\frac{1}{40}$  of an inch), while their shortest diameter is about .19mm. The earstones of these fishes are so exceedingly small that they are easily overlooked.

## IV.—LITERATURE.

The following are some papers in which the otoliths of fishes are more or less specially dealt with:—

- Dr. REIBISCH.—“Ueber die Eizahl bei *Pleuronectes platessa* und die Altersbestimmung dieser Form aus den Otolithen.” *Wissensch. Meeresuntersuch.*, 1899. Neue Folge Bd. 4, Abthlg. Kiel, p. 231. (This work I have not seen.)
- Dr. C. FRYD.—“Die Otolithen der Fisch in Bezug auf ihre Bedeutung für Systematic und Altersbestimmung.” Dissertat. Kiel, 1901. (I have not seen this paper.)
- Dr. J. T. JENKINS.—“Altersbestimmung durch Otolithen bei den Clupeiden.” *Wissensch. Meeresuntersuch.*, 1902. Neue Folge Bd. 6, Abthlg. Kiel, p. 83.
- J. T. CUNNINGHAM.—“Zones of Growth in the Skeletal Structures of the Gadidæ and Pleuronectidæ.” *Twenty-third Annual Report of the Fishery Board for Scotland*, Pt. III., p. 125, et seq., pls. vii.-ix., 1905.
- Dr. W. WALLACE.—“Preliminary Investigations on the Age and Growth rate of Plaice.” *International Investigations, Marine Biol. Assoc. Report*, pp. 199-225, pl. i., 1895.
- Dr. ADOLF SEVERIN JENSEN.—“On Fish Otoliths in Bottom Deposits of the Sea.” *Meddelelser fra Kommissionen for Havundersøgelse*. Ser. Fiskeri Bd. 1, pp. 1-14, with figures in the text, 1905.

Some observations on Fish Otoliths by the writer will also be found in Part III. of the *Twentieth* and *Twenty-first Annual Reports of the Fishery Board for Scotland*, p. 486 and p. 218, 1902 and 1903.

## EXPLANATION OF THE PLATES.

a=anterior end of otolith; u=upper margin of otolith.

## PLATE I. A.

Fig. 1-10.	Earstones of Codfishes, various sizes	slightly enlarged.
Fig. 11-13.	Lythe, „	„
Fig. 14-16.	Coel-fishes, „	„
Fig. 17-18.	(?) Ling, „	„
Fig. 19-26.	Ling, „	„
Fig. 27.	a Greater Forkbeard, „	„

## PLATE I. B.

Fig. 1-8.	Earstones of Lesser Forkbeard, various sizes	slightly enlarged.
Fig. 9-12.	several 3-Bearded Rocklings, various sizes	„
Fig. 13-17.	several 4-Bearded Rocklings, „	„
Fig. 18.	one Flounder, „	„
Fig. 19-25.	several Lemon Dabs, various sizes	„
Fig. 26-29.	four Witch Soles, „	„
Fig. 30.	one Scald-fish, „	„
Fig. 31-32.	two Megrimms „	„
Fig. 33.	one Turbot „	„
Fig. 34.	one Black Sole „	„
Fig. 35-36.	two <i>Solea variegata</i> „	„
Fig. 37-41.	several Solenettes, various sizes „	„
Fig. 42-43.	two Müller's Topknots „	„
Fig. 44-45.	two Argentines „	„
Fig. 46-52.	several Grey Gurnards, various sizes „	„
Fig. 53.	one Red Gurnard „	„
Fig. 54-55.	two Streaked Gurnards „	„
Fig. 56.	one Sapphirine Gurnard „	„
Fig. 57-63.	several Lumpenus, various sizes „	„
Fig. 64-65.	two Sand-eels „	„
Fig. 66.	one Conger „	„
Fig. 67-69.	three Fresh-water Eels „	„

PLATE II. A.

Fig. 1-5 and 9-16.	Earstones of Haddocks, various sizes	slightly enlarged.
Fig. 6-8 and 30, 31.	„ Whittings, „	„
Fig. 17-24.	Earstones of Brassies, various sizes	„
Fig. 25-28.	„ Norway Pouts, various sizes	„
Fig. 29.	„ one Couch's Whiting	„

PLATE II. B.

Fig. 1-5.	Earstones of Megrims, various sizes	slightly enlarged.
Fig. 6-7.	„ two Sea Breams	„
Fig. 8-9.	„ two Lesser Weavers	„
Fig. 10.	„ one Greater Weaver	„
Fig. 11.	„ one Bass	„
Fig. 12-14.	„ three Ballan Wrasses	„
Fig. 15.	„ one Striped Wrasse	„
Fig. 16.	„ one Jago's Goldsinny	„
Fig. 17.	„ one Lesser Grey Mullet	„
Fig. 18.	„ one Pogge	„
Fig. 19-20.	„ two Black Gobies	„
Fig. 21-24.	„ four Speckled Gobies	„
Fig. 25-27.	„ three Powans	„
Fig. 28-29.	„ two Dabs	„
Fig. 30.	„ one Trout	„
Fig. 31.	„ one Salmon	„
Fig. 32.	„ one Sand-eel	„
Fig. 33.	„ one <i>Liparis</i>	„

PLATE III. A.

Fig. 1-6 and 14.	Earstones of Halibut, various sizes	slightly enlarged.
Fig. 7-13.	Earstones of Long Rough Dabs, „	„
Fig. 15-21.	„ Plaice, „	„
Fig. 22-26.	„ Witch Soles „	„
Fig. 27-31.	„ Dabs „	„
Fig. 32-25.	„ Hake „	„

PLATE III. B.

Fig. 1-9.	Earstones of Spotted Dragonets, various sizes	slightly enlarged.
Fig. 10-14.	„ Dragonets, „	„
Fig. 15-24.	„ Herrings, „	„
Fig. 25-32.	„ Sprats, „	„
Fig. 33.	„ one Pilchards	„
Fig. 34-35.	„ two Atherines	„
Fig. 36.	„ one Mackerel	„
Fig. 37.	„ two Viviparous Blennies	„
Fig. 38-39.	„ two Butterfishes	„
Fig. 40-43.	„ four Catfishes	„
Fig. 44-46.	„ three Pogges	„
Fig. 47.	„ one <i>Chimarra</i>	„
Fig. 48.	„ one Grey Mullet	„
Fig. 49.	„ one Red Mullet	„
Fig. 50-52.	„ three Norway Haddocks	„
Fig. 53.	„ one <i>Scorpena ductyloptera</i>	„
Fig. 54-57.	„ four fresh-water Perches	„
Fig. 58.	„ one Lumpsucker	„
Fig. 59.	„ one Roach	„
Fig. 60.	„ one fresh-water Pike	„
Fig. 61-62.	„ two <i>Lophius</i>	„
Fig. 63-65.	„ three <i>Cottus</i>	„

PLATE IV.

Fig. 1.	Earstones of a small Haddock	considerably enlarged.
Fig. 2.	„ a Haddock, 14 inches long	„
Fig. 3.	„ a <i>Gadus luscus</i>	„
Fig. 4.	„ a <i>Gadus esmarkii</i>	„
Fig. 5.	„ a <i>Gadus poutassou</i>	„

Fig. 6.	Earstones of a Lesser Forkbeard	considerably enlarged.
Fig. 7.	„ a Lesser Forkbeard (very young)	„
Fig. 8.	„ a small Ling	„
Fig. 9.	„ an Argentine	„
Fig. 10 and 11.	„ two 4-Bearded Rocklings	„
Fig. 12 and 13.	„ two Grey Gurnards	„
Fig. 14.	„ a small Conger	„
Fig. 15.	„ a Red Gurnard	„
Fig. 16.	„ a Turbot	„
Fig. 17.	„ a Black Sole	„
Fig. 18.	„ a 3-Bearded Rockling	„
Fig. 19.	„ a Fresh-water Eel	„
Fig. 20.	„ a Streaked Gurnard	„
Fig. 21.	„ a Sapphirine Gurnard	„
Fig. 22, 23, 26 and 27.	Earstones of four Lumpenus	„
Fig. 24 and 25.	Earstones of two Solenettes	„
Fig. 28 and 29.	„ two Solea variegata	„
Fig. 30.	Earstones of a Witch Sole	„
Fig. 31.	„ Lophius piscatorius	„

## PLATE V.

Fig. 1 and 2.	Right and left earstones of two Megrima	considerably enlarged.
Fig. 3 and 4.	Earstones of two Herrings	„
Fig. 5.	Earstones of a Roach	„
Fig. 6.	„ a Black Goby	„
Fig. 7.	„ a Conger, 54 inches long	„
Fig. 8.	„ a Ballan Wrasse	„
Fig. 9.	„ a Salmon, weighing 10 lbs.	„
Fig. 10 and 11.	„ two Common Dragonets, 112mm. long	„
Fig. 12.	„ a Lesser Grey Mullet	„
Fig. 13.	„ a Fresh-water Perch	„
Fig. 15.	„ a Lump sucker, 15½ inches long	„
Fig. 16-17.	„ three Sprats	„
Fig. 18 and 24.	„ two Spotted Dragonets	„
Fig. 19.	„ a Lophius, 36 inches long	„
Fig. 20.	„ a Fresh-water Pike	„
Fig. 21.	„ a Catfish, 27 inches long	„
Fig. 22 and 26.	„ two Atherines, 3½ and 5 inches long	„
Fig. 23.	„ a Mullus barbatus	„
Fig. 25.	„ a Fresh-water Eel	„
Fig. 27.	„ a Pogge, 5½ inches long	„
Fig. 28.	„ a Lemon Dab, 15 inches long	„
Fig. 29.	One Earstone of a Coregonus, 8 inches long	„
Fig. 30.	Earstones of a Cydogaster liparis	„
Fig. 31.	One Earstone of a Viviparous Blenny	„
Fig. 32.	„ a Pilchard	„
Fig. 33.	„ a Mackerel	„









1. The first part of the document is a list of names.

2. The second part of the document is a list of names.

3. The third part of the document is a list of names.

4. The fourth part of the document is a list of names.

5. The fifth part of the document is a list of names.

6. The sixth part of the document is a list of names.

7. The seventh part of the document is a list of names.

8. The eighth part of the document is a list of names.

9. The ninth part of the document is a list of names.

10. The tenth part of the document is a list of names.

11. The eleventh part of the document is a list of names.

12. The twelfth part of the document is a list of names.

13. The thirteenth part of the document is a list of names.

14. The fourteenth part of the document is a list of names.

15. The fifteenth part of the document is a list of names.

16. The sixteenth part of the document is a list of names.

17. The seventeenth part of the document is a list of names.

18. The eighteenth part of the document is a list of names.

19. The nineteenth part of the document is a list of names.

20. The twentieth part of the document is a list of names.

21. The twenty-first part of the document is a list of names.

22. The twenty-second part of the document is a list of names.

23. The twenty-third part of the document is a list of names.

24. The twenty-fourth part of the document is a list of names.

25. The twenty-fifth part of the document is a list of names.

26. The twenty-sixth part of the document is a list of names.

27. The twenty-seventh part of the document is a list of names.

28. The twenty-eighth part of the document is a list of names.

29. The twenty-ninth part of the document is a list of names.

30. The thirtieth part of the document is a list of names.

















in the U. S. Commissioner's Report on Fish and Fisheries. 1888, Part xvi., 1892). This report deals with the chemical composition and nutritive values of food fishes and aquatic invertebrates. Analyses were made of the flesh of 123 specimens of American fishes belonging to 52 species, and among these are given analyses of fresh, salted, and pickled herrings. He also collects all the analytical literature and gives a table of the maximal, minimal, and average amounts of the food principles present in the herring as given by different authorities.

I give it here in order to show that there are marked variations in the analytical results, especially as regards the fat.

	Water.	Water-free Substance.	Protein i.e. $N \times 6.25$ .	Fats.	Ash.
Maxima.	76.11	30.97	19.12	11.01	1.9
Minima.	69.03	23.89	15.31	4.89	1.5
Average.	72.10	27.90	17.75	8.02	1.69

Atwater adopted all the precautions which he thought necessary to render his analyses accurate, and devotes some part of his paper to a criticism of the methods of analyses employed by his predecessors, explaining in some cases the differences in the results by probable analytical errors. A very important and most probable cause of divergence in the analytical results was a difference in the condition of the herring at the time of the analysis. As we shall see, there are great differences in composition of the muscle of the herring at different periods, and these differences are to be observed in herrings obtained from the same waters, when they are examined at different months of the year.

For purposes of comparison it is extremely desirable that the herrings should be obtained from the same district at regular intervals for at least two years, and that analyses should be made of muscles and genitalia.

This would be a work of no great difficulty if three or four persons were occupied with the investigation, but it could not be covered by a single worker unless he devoted his whole time to the work. I have been unable to devote more than a comparatively small portion of my time during the last two years to the work, and it is only during the last year that I obtained satisfactory material for the research.

The work, therefore, will deal with herrings mainly obtained from the Loch Fyne district during 1905 and 1906.

Only these fish were employed for analysis which had arrived at the laboratory in absolutely fresh condition. During the summer months they were sent in a double walled japanned tin carrier, an ice-salt mixture filling the space between the two walls. At other times they were sent with salt sprinkled over them or without any preservative.

The fish were measured and weighed, and the ovaries or milt removed, weighed, and examined microscopically, the ova being measured by means of an ocular micrometer. The measurement for length was made from end of snout to end of tail fin; for girth, in front of the dorsal fin around the thickest part of the fish. The measurements are given in centimetres.

The weights of the fish and reproductive organs are given in grammes.

# METHODS OF ANALYSIS.

It was impossible to adopt many precautions which might have been desirable, owing to the necessity for carrying through the analysis as quickly as possible.

Such estimations as these of the percentage of water in the muscles and reproductive organs cannot be carried out in such a way as to absolutely prevent loss of weight from any other cause than the removal of water.

(1) *Water percentages.*—The skin was removed, then as much of the muscular tissue as could be conveniently obtained was minced up extremely fine by being passed through a mincing machine.

Specimens were taken between watch glasses and dried in a warm oven at a temperature between 60°–70°C., under conditions where oxidation was prevented as far as possible, the final drying being carried out in vacuo.

The same procedure was adopted in the case of the reproductive organs.

(2) *Nitrogen and Phosphorus estimations.*—It was of course necessary to estimate the amount of nitrogenous material in the muscles and genitalia, and it was also thought advisable to estimate the amount of phosphorus.

The total nitrogen was estimated in a small portion of muscle and also in a similar quantity of ovary or milt respectively, the method that was adopted being that of Kjeldahl.

For purposes of convenience the numbers for the total nitrogen are not given in the tables, but are converted into terms of protein by multiplying the amount of the total nitrogen by the usual factor, 6.25. This is, of course, simply a matter of convenience, some of the nitrogen being present in other forms than protein. As, however, by far the most important nitrogenous constituent in the muscles and genitalia is the protein, probably not more than 2 per cent. of other nitrogenous constituents being present, it is sufficient to state the amounts of total nitrogen in terms of protein.

The phosphorus was estimated in a portion of the fluid obtained after incineration by the Kjeldahl method.

The fluid was rendered ammoniacal, then acidified with nitric acid, and the phosphate then precipitated by ammonium molybdate. The phosphomolybdate precipitate was subsequently dissolved in ammonia, and the phosphate precipitated by magnesia mixture. The triple phosphate was then received on an ash-poor filter paper, washed, dried, and incinerated. It was then weighed and the weight of the  $Mg_2P_2O_7$  was then calculated in terms of  $P_2O_5$ , and given as such in the tables.

(3) *Fat.*—The finely powdered dried material (muscles or genitalia) was placed in a Soxhlet filter paper tube and extracted with ether in the usual way for about 36–48 hours. Only about 3–4 grammes of the dried material were taken, so that the extraction ought to have been fairly complete. The fat was freed from ether and weighed in the usual way.

In the tables the amounts of proteid, fat, and  $P_2O_5$  are given in two forms, first, in grammes per 100 grammes fresh muscle and fresh ovaries or milt; secondly, in terms of grammes in total fresh muscle or genitalia respectively, as calculated for the average fish of the batch under examination.

It was thought advisable not only to give the percentage amounts of proteid, fat, and  $P_2O_5$ , but also the absolute amounts in the muscles and genitalia respectively of the same fish. The weight of the muscles of the fish was obtained roughly by deducting  $\frac{1}{3}$  of the total weight, this fraction being supposed to cover the weight of the head and bones.

Tables are also given showing the ratios which exist between the weight of the fish and that of the reproductive organs at different periods, and also those existing between the more important constituents of muscles and genitals.

LOCH FYNE HERRING, MAY 10, 1906.

(Otter.)

Length.	Girth.	Weight.	Condition
Cm.	Cm.	Gm.	
25	11½	113	Very immature, probably previously spent herring from condition of ovarian capsule.
23½	11	101	
22½	12	104	
23½	11	102	There were large numbers of very small ova present, varying in size from .07-.15mm.
23	10½	93	
23	10	90	
23	10½	88	
21½	10½	80	
22½	10½	85	
22	10	80	
21½	10	74	
22	10	75	
22.9cm.	10.7cm.	90.4gm.	Average.

Weight of genitals (fresh) of 12 herrings, 2.5 grammes. The water percentage of these genitals was 71.52.

*Analyses of the muscles of these herring:—*

*Females—*

(a) Amounts stated in percentages of fresh material.

In grammes per cent.	Water. 72.69	Proteid. 18.98	Fat. 7.25	P <sub>2</sub> O <sub>5</sub> .68
-------------------------	-----------------	-------------------	--------------	--------------------------------------

(b) Grammes in the total muscles of the average fish of this series.

In grammes,	Proteid. 11.38	Fat. 4.35	P <sub>2</sub> O <sub>5</sub> .40
-------------	-------------------	--------------	--------------------------------------

ARDRISHAIG, MAY 11, 1906.

These herring were very small, and, with one exception, contained very immature ovaries. One herring (No. 11) contained ovaries which weighed 14.75 grammes, and the ova which were present measured 1.2mm. in diameter and were being discharged.

The immature ovaries, although they contained large numbers of very small ova, were evidently comparatively recently spent (*see* following pages for measurements and analyses).

	Length.	Girth.	Weight.	Condition.
	Cm.	Cm.	Gm.	
Series A. 1	20	8.5	58	The ova were very immature. The weight of the 10 pairs of genitals was 2.4gm. in the fresh condition.
2	20.5	9	60	
3	20.5	9.5	67	
4	20.5	9.5	67	
5	20.5	9	64	
6	21	9	72	
7	21.5	10	75	
8	22.5	9	75	
9	21	9.5	70	
10	25	11	116	
Average,	21.3cm.	9.4cm.	72.4gm.	
.11	23	10	91	Ovaries weighed 14.75 gm., and their ova measured 1.2mm.

*Analyses of the muscles of these herring :—*

*Females—*

*Series A—(fish with immature ovaries previously spent).*

(a) Amounts stated in percentages of fresh material.

In grammes per cent.	Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
	73.01	17.55	5.85	.82

(b) Grammes in the total muscles of the average fish in the series.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
8.47	2.82	.39

*B—(herring with mature ovaries).*

(a) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
72.9	20.58	3.52	.51

(b) Grammes in total muscles of fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
12.34	2.11	.48

JULY 29, 1905.\*

Length.	Girth.	Weight.	Weight of Genitals.
Cm.	Cm.	Gm.	Gm.
24	12	116	0·35
22	11·5	96	0·46
23·5	12	99	0·20
23	13	120	0·67
23	11·5	91	0·20
22·5	12	105	0·74
23	12	107	0·33
24	12·5	124	1·18
21·5	11	82	0·49
22·5	12	105	0·43
22·5	11·5	102	0·39
22	11	92	0·22
23	12	97	0·15
24	13	127	0·50
22·5	12	100	0·44
25	13	137	0·53
24	12·5	119	0·81
22	11	88	0·20
22	11	92	0·20
23	13	120	0·65
Avg. 22·9	11·9	100·9	0·45

These herring were still in immature condition; the ova were only slightly larger than in the herrings caught on May 10.

*Analyses of the muscle (fresh):—*

(a) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
71·60	18·18	7·32	·45

(b) Grammes in the total muscles of the average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
12·18	4·90	·30

*Analyses of the genitals (fresh):—*

(a) Grammes in 100 grammes of fresh material.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
72·5	13·52	8·92	·77

(b) Grammes in the amount of genitals present in the average fish of series.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
·05	·03	·003

\* For analyses of the muscles of herrings caught in Loch Fyne during the latter part of May and beginning of June 1906, see pp. 103–107.



ARDRISHAIG, SEPTEMBER 15, 1905.

These herring were very small, the average length of six females being 20cm., and the average weight 80 grammes. The weight of the ovaries in these six herrings was 5·70 grammes weighed in the fresh condition—that is to say, the average weight per fish was ·95 grammes. The ova were very immature, varying in size from ·15mm.—·45mm.

The male herrings had approximately the same measurements, the average length of eleven being 20cm., and the average weight ·75 grammes. The testes from these eleven herrings weighed 10·65 grammes in the fresh condition, i.e., ·97 grammes per fish.

*Analyses:—*

*Females—*

I.—Muscles.

(a) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
63·68	19·28	11·81	·64

(b) Grammes in total muscles of average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
10·41	6·37	·34

II.—Ovaries.

(a) Grammes in 100 grammes fresh ovaries.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
66·02	18·91	7·34	1·23

(b) Grammes in ovaries of average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
0·17	0·07	·011

*Males—*

I.—Muscles.

(a) In percentages of fresh material.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
61·68	18·65	14·25	·52

(b) Per average fish in total muscles.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
9·32	7·12	·25

II.—Testes.

(a) In 100 grammes fresh material.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
72·00	22·18	2·84	—

(b) In total testes of average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
0·21	0·27	—

OCTOBER, 1905 (Loch Fyne).

Some of these herrings were in rather a more mature condition than others, and so the females have been divided into two series for analysis; first, those with ovaries containing ova of about ·28mm. in diameter, and, secondly, those whose ova averaged ·59mm.

**SERIES A.**

Length.	Girth.	Weight.	Condition.
Cm.	Cm.	Gm.	The ovaries from these 7 herrings weighed collectively 17gm., and the average size of ova was .28mm.
28	15	206	
27	13.5	150	
25	13	147	
24.5	12.5	130	
23.5	12	115	
23.5	12.5	122	
26	13	148	
25cm.	13cm.	144.5gm.	Average.

**SERIES B.**

Length.	Girth.	Weight.	Condition.
Cm.	Cm.	Gm.	The ovaries from these 8 herrings weighed collectively 74gm., and the average size of the ova was .59mm.
29.5	16	257	
28.5	15.5	220	
27.5	13.2	167	
24.5	12.5	129	
24	12.2	119	
25	14.5	220	
29.5	15.5	229	
28	14	197	
27cm.	14cm.	192gm.	Average.

**Males.**

Length.	Girth	Weight.	Condition.
Cm.	Cm.	Gm.	The testes from 4 of these herrings weighed collectively 96gm.
28.5	16	242	
30.5	17	275	
27	14.4	157	
27	13.2	157	
27.5	14.5	185	
25	12.5	135	
25.5	12.5	143	
25.5	3	143	
26	12	119	
27	13	145	
27	12.2	123	
26.7cm.	13.6cm.	166gm.	Average.

*Analyses of Females :—*

Series A.

Muscles.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
69·97	12·78	14·25	·53

(b) In total muscles of average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
12·39	13·82	·51

Ovaries.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
78·21	17·26	2·53	·71

(b) In ovaries of average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
·41	·33	·01

Series B.

Muscles.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
70·46	14·84	12·70	·57

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
14·80	12·51	·55

Ovaries,

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
68·02	22·45	4·80	·93

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
2·08	·44	·05

*Males—*

Muscle.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
68·91	16·18	12·63	·50

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
18·44	14·39	·57

Testes.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
72·13	22·62	2·25	·86

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
5·42	·54	·13

ARDRISHAIG, NOVEMBER 6, 1905.

These herring were large and in good condition, and the ova were almost mature. They have been divided into two sets, females and males, the measurements of which are as follows :—

I. *Females.*

Length.	Girth.	Weight.	Weight of Ovaries.
Cm.	Cm.	Gm.	Gm.
30	16·5	275	35·7
31	16	270	38·2
33	17·5	326	51·6
31	16	255	31·8
30	16	261	25·6
31	16	260	18·9
32	16·5	297	31·6
32	17	290	35·2
32	16·5	275	31·4
30	16·5	276	28·8
32	16·5	304	32
29	15	210	20·1
30	15	204	15·4
29	14	192	15·8
Avg. 30·8cm.	16cm.	264gm.	29·5gm.

The ova were from ·8–1mm. in diameter.

II. *Males.*

Length.	Girth.	Weight.	Weight of Testes.
Cm.	Cm.	Gm.	Gm.
31	17	279	44·5
31	17	316	52
31	16	277	40·6
29	14	215	31·4
30	16	257	40·9
33	16	296	37·3
32	16	287	40·1
30	17	290	41·1
31	17	303	46·6
31	16	252	35·6
31	15·5	230	26·8
29	14·5	195	24·4
30	16	255	44·6
Avg. 30·7cm.	16cm.	265·5gm.	38·9gm.

*Analyses :—*

*Females—*

**Muscle.**

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
66·34	19·87	10·85	·59

(b) In total muscles of average fish.

Proteid.	Fat	P <sub>2</sub> O <sub>5</sub>
52·45	28·64	1·55

**Ovaries.**

(a) In percentages of fresh material.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
68·04	25·04	2·85	·91

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
7·38	·84	·26

*Males—*

**Muscle.**

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
68·22	17·94	10·84	·46

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
31·77	19·18	·81

HELMSDALE HERRINGS, DECEMBER 6, 1905.

Two herrings (females) were taken for analysis from a batch containing fish of approximately the same size. Their measurements were :—

Length.	Girth.	Weight.	Weight of Ovaries.
Cm.	Cm.	Gm.	Gm.
29	14·5	195	26
29	14·5	194	35
Avg. 29cm.	14·5cm.	194·5gm.	30·5gm.

Size of ova, ·8–1·2mm. These herring had evidently commenced to spawn.

*Analyses :—*

**Muscle.**

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
70·50	23·01	2·75	·77

(b) Per average fish (total in muscles).

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
28·76	3·4	·96

## Ovaries.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
65·73	27·76	3·34	1·19

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O
9·82	1·00	·34

LOCH GAIR, DECEMBER 13, 1905.

These fish were very large, with ovaries of greater weight than in any other herrings which were analysed. The ova varied in size from ·9mm. to 1·2mm.

The following were the measurements:—

*Females.*

Length.	Girth.	Weight.	Weight of Ovaries.
Cm.	Cm.	Gm.	Gm.
31	17·5	326	63
30·5	15	268	43
30·5	16·5	272	30
31	16·5	330	48
30·5	16	285	47
31	17·5	318	51
Avg. 30·7cm.	16·5cm.	299·8gm.	47gm.

*Males.*

Length.	Girth.	Weight.	Weight of Testes.
Cm.	Cm.	Gm.	Gm.
31	17	298	61
31	17	320	55
Avg. 31	17cm.	309gm.	58gm.

*Analyses:—**Females.*

## Muscle.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
67·36	20·56	8·18	·68

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
41·12	16·36	1·37

Ovaries.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
67·33	25·72	2·89	1·03

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
12·08	1·35	·48

Males.

Muscle.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
68·31	21·45	9·24	·73

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
44·18	19·03	1·51

Testes.

(a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
72·10	22·05	3·73	2·10

(b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
12·78	2·16	1·21

LOCHBOISDALE HERRING, DECEMBER 28, 1905.

These fish were either spawning or spent. They have therefore been divided into two classes for examination—one, Series A, spawning, the ova varying in size from ·9mm. to 1·4mm; the other, Series B, spent.

The males were not examined.

SERIES A.

Length.	Girth.	Weight.	Weight of Ovaries.
Cm.	Cm.	Gm.	Gm.
27·5	13·5	165	18
26·5	14	157	14·8
26	13·5	141	25
26	12	127	11·5
26·5	13	168	20·3
26	14	160	18·3
26	13	150	19·4
25	12	115	10·5
26	13·5	150	18·8
Avg. 26cm.	13cm.	148gm.	17·4gm.

## SERIES B (spent).

Length.	Girth.	Weight.
Cm.	Cm.	Gm.
23	12	153
28	12	140
Avg. 25.5cm.	12cm.	146.5gm.

## Series A (spawning).

## Muscles.

## (a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
74.12	18.91	2.02	.66

## (b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
18.15	1.93	.61

## Ovaries.

## (a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
70.00	24.75	3.72	.93

## (b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
4.23	.63	.16

## Series B.

## Muscles.

## (a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
75.30	19.69	1.55	.77

## (b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
18.53	1.51	.75

FEBRUARY 8, 1906.

These herring were in the spent condition. Six females were taken for examination. Their measurements were as follows:—

Length.	Girth.	Weight.
Cm.	Cm.	Gm.
26	11	115
28	12	143
28	12	155
29	13	156
29	12	150
28	12	136
Avg. 28cm.	12cm.	142.5gm.



7½ pairs of spent ovaries were taken from herrings sent at this time, and were found to weigh 9·51 grammes. These were dried and analysed.

## I.—Muscles.

## (a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
78·97	18·05	0·68	·73

## (b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
16·60	0·62	0·66

## II.—Ovaries (spent).

## (a) In percentages.

Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
82·07	3·78	11·83	·91

## (b) Per average fish.

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
·29	·09	·016

Before discussing these results it will prove of some advantage to compare the ratios which exist between the weight of the fish and the weight of the ovaries, as well as certain other ratios.

RATIO OF WEIGHT OF FISH TO WEIGHT OF OVARIES AT  
DIFFERENT SEASONS:—

District and Period.	Weight of Fish.	Weight of Ovaries.	Condition.
Loch Fyne—May 10, . . . . .	434·6	1	Immature.
„ May 11—Series A, . . . . .	301·6	1	Immature.
„ May 11—Series B, . . . . .	6·1	1	Mature.
„ July 29, . . . . .	224·2	1	Immature.
„ Sept. 15, . . . . .	84·2	1	Immature (Ova ·15–45mm.).
„ Oct.—Series A, . . . . .	60·2	1	Immature (Ova ·28mm.).
„ Oct.—Series B, . . . . .	20·8	1	Immature (Ova ·59mm.).
„ Nov. 6, . . . . .	8·9	1	Almost mature (Ova ·8–1mm.).
Helmsdale—Dec. 6, . . . . .	6·3	1	Almost mature (Ova ·8–1·2mm.).
Loch Fyne—Dec. 13, . . . . .	6·3	1	Mature (Ova ·9–1·2mm.).
Lochboisdale—Dec. 28—Series A, . . . . .	8·5	1	Spawning.
„ Dec. 28—Series B, . . . . .	Spent.	Spent.	Spent.
„ Feb. 8, . . . . .	„	„	Spent.

## RATIO OF PROTEID TO FAT IN THE MUSCLES AND OVARIES RESPECTIVELY:—

District and Period.	Muscles.	Ovaries.	Condition.
	Proteid : Fat.	Proteid : Fat.	
Loch Fyne—May 10, . . . . .	2·61 : 1	— —	Immature.
„ May 11—A, . . . . .	3·00 : 1	— —	Immature.
„ May 11—B, . . . . .	5·84 : 1	— —	Mature.
„ July 29, . . . . .	2·48 : 1	1·51 : 1	Immature.
„ Sept. 15, . . . . .	1·63 : 1	2·57 : 1	Immature (Ova ·15–45mm.).
„ Oct.—A, . . . . .	0·89 : 1	6·82 : 1	Immature (Ova ·28mm.).
„ Oct.—B, . . . . .	1·16 : 1	4·67 : 1	Immature (Ova ·59mm.).
„ Nov. 6, . . . . .	1·83 : 1	8·78 : 1	Almost mature (Ova ·8–1mm.).
Helmsdale—Dec. 6, . . . . .	8·36 : 1	8·31 : 1	Almost mature (probably about to spawn).
Loch Fyne—Dec. 13, . . . . .	2·51 : 1	8·9 : 1	Mature (about to spawn).
Lochboisdale—Dec. 28—A, . . . . .	9·36 : 1	6·65 : 1	Spawning.
„ Dec. 28—B, . . . . .	12·70 : 1	— —	Spent.
„ Feb. 8, . . . . .	26·54 : 1	3·12 : 1	Spent.

RATIO OF TOTAL PROTEID OF MUSCLES TO TOTAL PROTEID  
OF OVARIES.

District and Period.	Muscle Proteid : Ovarian Proteid.	Condition.
Loch Fyne—May 10, . .	- -	
" May 11—A, . .	- -	
" May 11—B, . .	- -	
" July 29, . .	243·6 : 1	Immature.
" Sept. 15, . .	61·2 : 1	Immature (Ova ·15-·45mm.).
" Oct.—A, . .	30·2 : 1	Immature (Ova ·28mm.).
" Oct.—B, . .	7·1 : 1	Immature (Ova ·59mm.).
" Nov. 6, . .	7·1 : 1	Almost mature (Ova ·8-1mm.).
Helmsdale—Dec. 6, . .	2·9 : 1	Almost mature (Ova ·8-1·2mm.).
Loch Fyne—Dec. 13, . .	3·3 : 1	Mature (about to spawn).
Lochboisdale—Dec. 28—A, . .	4·2 : 1	Spawning.
" Dec. 28—B, . .	- -	Spent.
" Feb. 8, . .	57·2 : 1	Spent.

RATIO OF TOTAL FAT OF MUSCLES TO TOTAL FAT OF OVARIES.

District and Period.	Fat of Muscles : Fat of Ovaries.	Condition.
Loch Fyne—July 29, . .	163·3 : 1	Immature.
" Sept. 15, . .	91 : 1	Immature (Ova ·15-·45mm.).
" Oct.—A, . .	41·8 : 1	Immature (Ova ·28mm.).
" Oct.—B, . .	28·4 : 1	Immature (Ova ·59mm.).
" Nov. 6, . .	34 : 1	Almost mature.
Helmsdale—Dec. 6, . .	3·43 : 1	Almost mature (about to spawn).
Loch Fyne—Dec. 13, . .	12·1 : 1	Mature.
Lochboisdale—Dec. 28—A, . .	3 : 1	Spawning.
" Feb. 8, . .	6·8 : 1	Spent.

[TABLE.

# COMPOSITION OF MUSCLES AND OVARIES IN HERRINGS (Average Fish of each Series).

	PER FISH.				MUSCLE.								OVARIES.							
	Length.	Girth.	Weight.	Wt. of Ovaries.	PER CENT. IN FRESH MUSCLE				PER AVERAGE FISH.				PERCENTAGES.				PER FISH.			
					Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>	Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>	Water.	Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>				
May 10, . . .	Cm.	Cm.	Gm.	Gm.	72.69	18.98	7.26	.68	11.88	4.85	.40	72.5	13.52	8.92	.77	0.03	0.03	.003		
May 11, Series A, . .	22.9	10.7	90.4	.208	73.01	17.55	6.85	.82	8.47	2.82	.39	66.02	18.91	7.34	1.23	0.17	0.07	0.11		
" " B, . . .	21.3	9.4	72.4	.24	72.90	20.58	8.52	.81	12.34	2.11	.48	78.21	17.56	2.53	.71	.41	0.33	.01		
July 29, . . .	23	10	91	14.75	71.60	18.18	7.32	.45	12.18	4.90	.30	48.02	22.45	4.80	.93	2.08	0.44	.05		
Sept. 15, . . .	22.9	11.9	100.9	.45	63.68	19.76	11.81	.64	10.41	6.37	.34	68.04	25.04	2.85	.91	7.38	0.84	.26		
Oct Series A, . .	20	-	80	95	69.97	12.78	14.25	.68	12.39	13.82	.61	65.73	27.76	3.24	1.19	9.62	1.00	.24		
" " B, . . .	25	13	144.5	2.4	70.46	14.84	12.70	.57	14.80	12.51	.55	67.33	25.72	2.89	1.02	12.08	1.35	.48		
Nov. 6, . . .	27	14	192	9.2	66.84	19.87	10.85	.59	52.45	28.64	1.55	70.00	24.75	8.72	.93	4.23	0.63	.16		
Nov. 6, . . .	30.8	16	264	29.5																
Dec. 6 (Helmedale), . .	29	14.5	194.5	30.5	70.50	23.01	2.75	.77	28.76	3.43	.96									
" 13, (Loch Gair), . .	30.7	16.5	299.8	47	67.36	20.56	8.16	.68	41.12	16.36	1.37									
" 26, Series A, . .	26	13	148	17.4	74.12	18.91	2.02	.66	18.15	1.98	.61									
" " B, . . .	26.5	12	146.5	-	75.80	19.69	1.55	.77	18.53	1.51	.75									
Feb. 8, . . .	28	12	142.5	1.36	78.97	18.05	0.68	.73	16.60	0.62	.66	83.07	11.83	3.78	.91	.29	0.09	.016		



On looking over these tables, especially the one given on pp. 99, one is struck by the very marked variations in the composition of the muscle of the female at different periods during its reproductive life. In all probability much the same changes occur in the case of the muscles of the male herring during the growth of the testes, but the data which are given are insufficient to warrant one in drawing definite conclusions on this point.

#### SUMMARY OF RESULTS.

(1) The tables on pp. 97, 98, show clearly the alteration in the ratio between the weight of the fish and the weight of the ovaries before, during, and after spawning, the variations being produced by the proportionately much greater increase in the ovaries than in the rest of the fish during the period of maturation.

(2) As the muscles constitute the main source of the nutritive value of the herring, it is most important to recognise the variations in their composition. These are most striking, especially as concerns the percentage of fat, and as this food principle possesses such a high caloric value, any marked decrease in its amount lowers the nutritive value of the fish to a serious extent.

The lowest fat percentage which was obtained occurred in the large spent herrings obtained from Lochboisdale in February last, and the total amount of fat present in the collective muscles of the average fish was exceedingly small. The percentage amount of water in these muscles was higher than normal, but the proteid and  $P_2O_5$  percentages were but little affected.

The herrings obtained from the same district at the close of December of last year contained a slightly larger percentage of fat in their muscles, and of the two series of fish examined those which were spent contained rather less than those which were spawning.

In the herrings obtained from Helmsdale at the beginning of December, the fat percentage was but little above that of the Lochboisdale spawning fish. Some of these herring were evidently just about to spawn, the ovaries being very large.

The herrings obtained from Loch Gair about the middle of December show a moderately high percentage of fat, but still markedly lower than in any Loch Fyne herrings caught during the months of September, October, and November. The highest percentage of muscle fat was found in October fish.

In the summer fish from Loch Fyne, where the ovaries were in an immature condition the fat percentage was usually about that which is often given as the average for the herring. The fat percentage of the herring muscles, therefore, continues rising during the three months, probably, of August, September, and October. It begins to fall slightly in November, markedly in December, most markedly during spawning and continues at a low level until the fish begin to feed again.

The variations in the total amount of fat present in the muscles of the fish are practically the same as those observed in the percentages, except in cases where the herrings being extremely large—as, for example, the Loch Gair specimens—the absolute amount of fat present remains high although the percentage has commenced to fall. For further details with regard to the fat percentages the reader is referred to the tables.

The variations in the percentage amounts of proteid are less marked. It is naturally lowest when the fat percentage is highest unless in cases where the amount of water in the muscles is below the average when both proteid and fat may show a fairly high percentage.

(3) The fat percentage of the ovaries is highest, evidently, in the case of Loch Fyne herrings between the months of July and September. It is low at the time when the amount in the muscles is high. The absolute amount of fat in the ovaries per average fish is, of course, highest in the case of the large November and December fish. With the onset of spawning the absolute amount of fat begins to fall.

The total amounts of  $P_2O_5$  in the muscles and ovaries are highest during the months of November and December.

(4) The ratio of muscle proteid to ovarian proteid practically is the same as that between total weight of fish and total weight of ovaries (*see tables, pp. 97, 98*).

(5) The ratios between the muscle proteid and muscle fat, and ovarian proteid and ovarian fat are shown clearly in the table on p. 97. The most important ratios are those between the muscle proteid and muscle fat. Owing to the rise in the fat percentage during September, October, and November, it gradually approaches that of the proteid, and in the case of the October A series actually rises above the latter.

(6) The ratio between the muscle fat and ovarian fat is given in the table on p. 98.

(7) The composite table on p. 100, giving analyses of male muscle and testes is not sufficiently complete to enable one to draw definite conclusions from it, except in so far that the male muscle evidently undergoes the same changes as the female.

In the light of the above facts, it is interesting to compare the principal feeding times for these herring with the variations in their composition. Brook and Calderwood (Report on the Food of the Herring, Fourth Annual Report of the Fishery Board for Scotland, Edin., 1886, Appendix F. No. VI., pp. 102–128) state that on the West Coast of Scotland the principal spawning time is from February to April (*e.g.*, on the Ballantrae coast), while the principal feeding time is from April to September. The principal food is copepods, which are taken practically exclusively from April to June. Towards the end of the feeding time they are practically replaced by schizopods.

The spawning takes place, just as in the case of the East Coast fish, six to eight months after the richest feeding.

Heincke ("Naturgeschichte des Herrings," p. 48) has shown that the herring after spawning seeks a place where it can get ample food to recuperate. For example, the herrings of Schley, after leaving the spawning beds in June, take three or four months to feed up in Kiel Bay. In September and October they are fattest, and then begins anew the development of the reproductive organs, which up to this time was checked. This takes up the whole autumn and winter, the fish still taking food, but it is not used for the building up of fat, but for the development of the genitalia. With the increase in the development of the genitals, the desire for food diminishes until spawning time arrives, when no food is taken at all. There are thus three periods in the yearly life of the Schley herring :—

- 1st. The restitution or the feeding period. This continues for 3–4 months after spawning and is the principal feeding time. The spent thin fish during this period recovers and lays on a large amount of fat.
- 2nd. The ripening period. This continues for 6–7 months. The herring still continues to eat but gradually with less desire, while the sexual organs increase at the expense of the fat.
- 3rd. The spawning period. This continues for 2 months, and during this time feeding stops.

It is possible that for a short time (a month perhaps) after spawning the herring does not take food.

There are without doubt similar periods during the reproductive life of herrings from all districts. Heincke's statements with regard to the storage and using up of the muscle fat were based on no analytical evidence.

There are still many points in connection with variations in the metabolism in herrings during spawning which require to be worked out, especially the cycle of phosphorus between muscles and ovaries.

Before concluding, I should like to refer to a subject which is at present attracting a good deal of attention, namely, the nutritive value of spent herrings.

Statements are made vaguely as to the unwholesome character of the spent fish. Now, upon what foundation does this rest? Usually upon no further evidence than the general appearance of the flesh of the fish, which is undoubtedly poorer in fat than in the maturing herring. But the nutritive value of the fish does not depend solely upon the fat which it contains; the percentage of proteid must also be considered, and if the tables of analyses be consulted, it will be seen that in this respect the spent fish compare by no means unfavourably with the maturing or mature fish.

But there is one other point which one must bear in mind, namely, that in many cases spent fish contain a large percentage of fat in their muscles, and to illustrate this I include some tables of analyses of fish caught in Loch Fyne in May and June of this year. In many cases these were fish which were undoubtedly storing fat after the discharge of ova had taken place. It is true that this storage of fat does not take place to any marked extent until three or four months have elapsed since the last spawning took place, but still the herrings present the appearance, so far as the genitals are concerned, of spent fish.

Again, the poverty of fat in the muscles of freshly spent herring may render them more digestible in the case of some individuals at least.

One must also remember that fully mature fish about to spawn are in much the same condition as freshly spent fish (*vide* Helmsdale herrings, December 6), and yet these fish would scarcely be termed unwholesome.

It would have been of extreme value to have had analyses made of herrings which had left Loch Fyne in January and gone to Kilbrannan Sound and Campbeltown district; but unfortunately I was unable to obtain specimens.

I subjoin the analyses to which I have just referred.

Attention may be specially directed to the analyses of the flesh of the large spent fish of June 2, as these show a comparatively high fat percentage.

MAY 16, 1906.

The herrings sent on this date from Ardrishaig were young immature fish. The genitals of 16 of these herrings weighed only 2.15 grammes, and the ova were exceedingly small, .05--.08mm.

[TABLE.

The following table gives the measurements and weights:—

Length.	Girth.	Weight.
Cm.	Cm.	Gm.
19	8·5	50
20	9	63
19	9	58
19	8·5	42
22	10·5	75
19	9	51
20	9·5	63
19	8	45
21	9·5	63
20	9	57
19	8·5	57
20	9	55
20	8·5	46
19	8	45
19	8·5	50
18	8	38
Avg. 19·5cm.	8·8cm.	53gm.

*Analyses of the muscles of these herrings:—*

(a) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.
68·14	24·66	3·37

(b) Grammes in the total muscles of the average fish of this series.

Proteid.	Fat.
8·72	1·19

MAY 17, 1906 (Loch Fyne).

These herrings were much larger than those obtained on the previous day. Female fish were selected, and all were found to be in the spent condition, although large numbers of small ova (·08–3mm.) were present in the collapsed ovaries. The weight of the ovaries from nine fish was 7·53 grammes.

Measurements, &c., were as follows:—

Length.	Girth.	Weight.
Cm.	Cm.	Gm.
23	11·5	101
25	12	142
25	11·5	117
25	11	116
25·5	12	127
23	11·5	97
24·5	12	117
25·5	11·5	133
24·5	10	103
Avg. 24·5cm.	11·4cm.	117gm.



*Analyses of the muscles of these herring :—*

(a) Amounts stated in percentages of fresh material.

Water.	Proteid.	Fat.
74·88	18·76	2·65

(b) Grammes in total muscles of the average fish of the series.

Proteid.	Fat.
14·63	2·06

MAY 23, 1906 (Loch Fyne).

The herrings sent on this date varied in character. Some were undoubtedly spent herring, although large numbers of young ova were to be found in the ovaries; others were as certainly young immature herring. Thus a subdivision has been made into two classes.

SERIES A.

Length.	Girth.	Weight.	Genitals.
Cm.	Cm.	Gm.	Spent and re-maturing ovaries (ova ·08 – 2mm.); weight of ovaries from four fish, 4·15gm.
28	12·5	159	
27	12·5	160	
26	12	125	
25	12	122	
Avg. 26·5cm.	12cm.	141·5gm.	

SERIES B.

Length.	Girth.	Weight.	Genitals.
Cm.	Cm.	Gm.	Very small immature ovaries (ova ·06 – 1mm.); weight of ovaries of eight fish, 2·15gm.
23·5	11·5	104	
23	10·5	89	
22	11	89	
23	11	97	
22·5	11·5	95	
22	11·5	91	
20	11	94	
21	10	94	
Avg. 22cm.	11cm.	94gm.	

*Analyses of the muscles of these herrings :—*

In the case of these fish additional analyses were made in order to determine the amount of coagulable proteid present. Throughout this

paper the numbers given for "proteid" refer simply to the total nitrogen calculated as proteid by multiplying the amount of the former by 6.25.

In the case of these herrings a weighed quantity of fresh muscle was mixed up thoroughly with anhydrous sodium sulphate, the mixture boiled with alcohol to coagulate the proteid, and then the powder extracted frequently with boiling distilled water until all the sulphate was removed. The remainder, consisting of coagulated proteid, was incinerated in the usual way with sulphuric acid (Kjeldahl) and the nitrogen estimated. On multiplying the latter by the usual factor the amount of coagulable proteid was obtained.

(a) Amounts stated in percentages of fresh material.

Series A.—

Water.	Proteid.	Coagulable Proteid.	Fat.
70.81	20.67	18.71	5.34

Series B.—

67.58	19.95	16.13	9.57
-------	-------	-------	------

(b) Grammes in total muscles of fish.

	Proteid.	Coagulable Proteid.	Fat.
Series A. .	19.42	17.58	5.01
„ B. .	12.56	10.16	6.02

JUNE 2, 1906 (Loch Fyne).

These herrings were large spent fish with young ova in the ovaries. Females were selected for analysis.

Length.	Girth.	Weight.	Genitals.
Cm.	Cm.	Gm.	Weight of ovaries of these six fish, 10.7gm.
29	14	211	
28	13	180	
27	13	170	
26	13	165	
26	13	150	
26	12	138	
Avg. 27cm.	13cm.	169gm.	

Analyses :—

(a) In percentages of fresh material.

Water.	Proteid.	Fat.
72.35	17.81	9.11

(b) Grammes in total muscles of fish.

Proteid.	Fat.
30.09	15.39

JUNE 2, 1906 (Loch Fyne).

Fourteen young immature herrings were obtained on the same day as the spent fish of the preceding series.

Length.	Girth.	Weight.	Genitals.
Cm.	Cm.	Gm.	Weight of genitals of these fish, 3·6gm.
24	12	109	
23	11	96	
22	12	103	
21	11	83	
22	11	91	
22	10	77	
20	10	72	
21	9	62	
22	11	82	
21	9	69	
19	10	64	
19	9	56	
19	9	50	
19	9	50	
Avg. 21cm.	10cm	76gm.	

*Analyses of the muscles :—*

(a) In percentages of fresh material.

Water.	Proteid.	Fat.
63·02	21·06	12·52

(b) Grammes in total muscles of fish.

Proteid.	Fat.
10·74	6·38

IV.—REPORT ON THE OPERATIONS AT THE MARINE FISH  
HATCHERY, BAY OF NIGG, ABERDEEN, IN 1905. By  
Dr. T. WEMYSS FULTON, F.R.S.E., Scientific Superintendent.

(PLATES VI., VII.)

---

Last year, owing to the making of a new road at the Bay of Nigg, it was desired by the Town Council of Aberdeen, from whom the site of the hatchery is leased, that the hatchery and some of the buildings in connection with it should be transferred to an adjacent site and re-erected at their expense. This was agreed to by the Board, and the hatchery, the boiler and pump-house, and the store-house were accordingly taken down and re-built on ground lying to the north of the old site, and contiguous to it. This alteration involved a re-arrangement of the pipes to a considerable extent, and the opportunity was taken to effect some improvements which experience showed was desirable, both in connection with the pipes and pumping plant, and in connection with the buildings. The Town Council and the Burgh Surveyor, under whose charge the removal was made, gave every reasonable facility for these alterations and improvements being effected, and the hatchery is thus much better adapted for the work than it was before.

A strong wall of boulders, about two feet in thickness, has been built with concrete on the seaward face of the new site, so as to protect it from the action of the sea in storms; and this has been made continuous with the bulwark of boulders built up after the great storm in February 1900, which happened in conjunction with spring tides, when the site of the large spawning pond, then in course of construction, was flooded. Owing to the somewhat higher level of the ground at part of the new site, that next the road, it was necessary to excavate it to a small extent in order to keep the levels the same as formerly. This is required, as the water supplied to the hatching apparatus comes by gravitation from the storage or reservoir tank (*a*, fig. 1, plate VI.), to which it is pumped from the sea. Strong granite retaining walls have been built around the reservoir, and between it and the new site.

The establishment consists, in addition to the laboratory (shown at *a* in fig. 2, pl. VI.), of (1) a spawning pond, (2) a reservoir or storage tank, (3) the hatching-house, (4) boiler and pump-house, (5) a tank-house, (6) storehouse, and it may be desirable to give a brief description of the arrangements as they now exist.

The spawning pond (fig. 2, pl. VI.), which was the most costly part of the establishment, consists of a large concrete tank or pond sunk in the ground in order that it may be filled and emptied, according to the state of the tide, without pumping being required. The levels were arranged so that at high water of ordinary neap tides an average depth of four feet might be obtained in the pond. The tank is 90 feet in length by 35 feet in width, and has an average depth of  $7\frac{1}{2}$  feet, the bottom sloping to one end, where the depth is 10 feet; it is capable of holding about 160,000 gallons of sea water. The water is admitted from the beach by an inflow pipe 12 inches in diameter; the portion of this going through the embankment separating the pond from the beach is of iron, the remainder,

on the beach itself, being of fireclay pipes, which have answered very well, and have only given rise to trouble on one occasion, in the course of last spring, when a section had to be renewed. The end of the inflow consists of a length of an iron pipe, terminated by an upturned part, raised about two feet from the bottom, and covered with a large shield of wire-netting. This arrangement is to prevent the access of sand, debris, and weeds as far as possible. The outflowing water escapes by a flap-valve at the end of the pipe, beneath the up-turned portion, and on the same level as the rest of the pipe.

The water on entering goes into a small compartment of the pond called the filter chamber. Here it passes up through wire-netting, which may be of any dimension of mesh, and, if necessary, through filtering material. There are two slide-valves, one controlling the connection of the filtering chamber with the sea and the other the connection between the chamber and the pond. The water may be admitted direct to the pond, or it may be pumped from the filter chamber to the reservoir tank.

The latter (*a*, fig. 1, pl. VI.) is built of concrete on a natural mound lying between the new site and the spawning pond. It is a strong tank, 29 feet long, 7 feet high, and 20 feet in breadth, and capable of holding 15,570 gallons of water. It is from it that the supply to the hatching apparatus and to the tanks in connection with the laboratory is obtained during the night. It can be filled by the pumps in about two hours and a quarter. A pipe, carried through the concrete wall at the bottom, leads the water to the hatchery; another carries a supply to the tank-house for laboratory work, and another allows it to pass into the spawning pond. The pipe going to the tank-house is shown in fig. 2, pl. VI., at *e*, and the pipe entering the pond is on the left of the letter *e*, and close to it. The water from the reservoir may be filtered or unfiltered; the iron pipe which passes through the wall of the tank is connected with a flexible hose, the end of which enters a floating box, so arranged that the supply is drawn from the surface, where there is less matter in suspension, and through flannel or other material.

The hatching-house, as now arranged, measures  $49\frac{1}{2}$  feet in length by 24 feet in breadth, part of it being 28 feet wide. The height of the building is 18 feet; it is lighted by 16 windows, and is painted inside in light tints, the walls being pale green and the ceiling white (fig. 1, pl. VII.).

Two material improvements were made in the re-erection of the building. A concrete floor, suitably sloped, replaces the previous wooden floor, and is a great advantage, since the water which is spilled over the floor when the work is going on now flows away into convenient gutters, which are connected with the drain going to the beach. The hatchery is much drier now, and the appearance improved. A large sink, supplied with fresh or sea water, has been erected in the middle of the floor for washing hatching boxes, &c. The other chief improvement consisted in taking in the filtering apparatus, which were previously outside, and this was effected by extending the walls and roof, the gable being put further out. For the "tumbling-boxes," which impart automatically a certain movement to the hatching boxes, two brick chambers have been built below the concrete floor, each 4 feet 4 inches by 4 feet 8 inches, and  $3\frac{1}{2}$  feet in depth. One is in connection with the waste water from each side of the hatchery, that is, the water which leaves the hatching boxes and is carried to the pond.

The filters consist of one large box, 8 feet by 4 feet and by 2 feet deep, and several smaller boxes, which receive the water from the larger one. All these are fitted with filters of flannel or blanketing, on frames covered with wire-netting and made tight by rubber bands; all the water which comes from the reservoir must pass up through them by pressure, and it

then passes on to the hatching apparatus. These are 22 in number, and are of the Dannevig pattern. They are shown in fig. 1, pl. VII., which is a view of the inside of one end of the hatchery. The apparatus on each side are supplied by separate pipes.

The pump-house is contiguous to the hatchery room, and opens into it. It is provided with three Worthington direct-acting steam pumps, specially made for use with sea water, and brass lined. They are shown in fig. 2, pl. VII. They are so fitted up that any one of them, or all together, can be used to pump water from the filter-chamber, either to the reservoir or to the pond; there are two suction pipes, one for the large pump and one for the two smaller pumps. Steam is supplied by an upright donkey boiler, with two tubes, which is fitted with an injector and pump, but the town water supply can be used direct, the working pressure being usually 40lbs. The pump-house measures 18 feet 10 inches by 15 feet; its position is shown at *b* in fig. 1, pl. VI.

The tank-house, which is used in connection with the scientific researches at the laboratory, is built partly over one end of the large spawning pond (fig. 2 *c*, pl. VI.), and there is a platform along this side over the pond. It is provided with six concrete tanks, four of which have plate glass in front and back, and the other two plate-glass fronts only. The latter are 6 feet 4 inches long, 4 feet 3 inches deep, and  $3\frac{1}{2}$  feet high; the others are  $5\frac{1}{2}$  feet in length, the other dimensions being the same as in the larger tanks. These tanks may also be used for experiments with fresh-water fishes if desired, fresh water pipes being fitted up to them. A bench runs along one side and one end of the tank-house, provided with a central leaden gutter, and suitably sloped, and pipes are carried over it to supply either sea water or fresh water to small tanks and dishes.

The various operations in connection with the work at the hatchery have been described in previous reports. Here it may be enough to say that the adult living plaice, from which the spawn is procured, are kept in the large spawning pond from year to year, their food consisting chiefly of mussels. The plaice which die are removed from the pond as soon as observed, and a fresh stock to replace those lost in this way is obtained each autumn by sending the attendant out on trawlers working inshore, who brings them in in tubs through which a current of water is maintained.

When spawning begins, the eggs float in the water of the spawning pond, from which they are removed by a large net of mosquito netting, which is towed around the pond for an hour or so each day as a rule.

The eggs are then transferred to the hatching boxes, which receive a supply, as copious as possible, of clean filtered sea water, until hatching occurs; and when the larvæ have nearly, but not quite, absorbed the yolk they are transferred to the sea in suitable localities.

The cost of the hatching work is small. The scientific investigations carried on at the laboratory require that water should be pumped regularly to supply the tanks, dishes, and apparatus in the tank-house, and sometimes in the hatching room, and the only additional expense incurred in connection with the hatching work is for extra coal while the work is going on, for the assistance of a boy to help the attendant during the busiest weeks, and for the hire of boats to put out the fry. The total cost is estimated at under £100.

The hatchery has been of great advantage in connection with the demonstrations to fishermen from the coast of Scotland, who come each spring to the laboratory for this purpose. It forms a great attraction to them, and enables them to form useful conceptions as to what goes on naturally in the sea with respect to the reproduction of fishes, as well as furnishing them with specimens for the study of their development. As

mentioned below, four delegations of fishermen attended these demonstrations in the course of last spring.

During the season last year the eggs of the plaice were first discovered floating in the pond on 20th January, which is about the ordinary time when they first occur. Examination of the water some days earlier failed to reveal their presence, and only a few hundreds were obtained on the 20th. The number gradually increased up to about the middle of March, and after that declined, the last collection, of a few hundreds of eggs, being made on the 16th May.

The duration of the spawning in the pond was therefore about 117 days, which may be taken as approximately the period in the sea. The total number of eggs obtained was estimated at 40,110,000. The greater number were collected in March; the collections in February and April were nearly equal in quantity to one another; while in January and May comparatively few were obtained. The figures showing the quantity for each of the months, and the percentages in each month for the last three years, are as follows:—

	Number Collected.	Percentages.			
		1903	1904	1905	Mean.
January, - -	1,080,000	0·3	1·6	2·6	1·5
February, - -	9,242,000	18·0	26·1	23·0	22·3
March, - -	19,475,000	56·2	55·7	48·5	53·5
April, - -	9,431,000	24·1	16·4	23·5	21·3
May, - -	882,000	1·3	..	2·2	1·2

In two Tables which are included in this paper, the particulars are given from day to day of the number of eggs collected and the temperature and specific gravity of the water in the pond, in the hatchery, and on the beach, and of the quantities of fry which were placed in the sea.

It will be seen that the temperature of the water in the pond when the eggs were first obtained was about 3·5°C. (33·8°F.); that it remained low to about the end of March, and that towards the end of the spawning it had risen to 10°C. (50°F.) and over it, the highest reading being on 15th and 19th May, when the temperature was 10·6°C. (51·1°F.).

During the season trouble was occasionally caused by the filters, and the death-rate was larger than usual. The number of dead eggs (including, however, the shells of the eggs which had hatched), amounted to about 15,790,000, which gives a rate of 39 per cent. The estimated number of fry put out into the sea, as given in Table II (p. 115) may be stated at 24,500,000, when allowance is made for the shells of the eggs and the debris contained in the boxes.

Most of the fry were put out off Aberdeen in March, April, and May, the first lot on the 8th of March, and the last on the 23rd May. One lot, by the request of the fishermen of the district, was taken to St. Combs, further up the coast, on the 24th of April. The fry in this lot were estimated to number about 3,517,000, which were dispatched by rail under the charge of the attendant, the water in which they were placed having been previously cooled to a temperature of 1·5°C. (34·7°F.) to obviate risks in carriage. The number of adult plaice found in the pond, when it was cleaned out after the hatching season was over, was 282, and a fair number of dead fish and the remains of some others were removed.

TABLE I.—Showing the Daily Progress at the Hatchery, and the Temperature and Specific Gravity of the Water.

Date.	Eggs Collected.	Eggs Dead.	In Pond.		In Hatchery.		On Beach.	
			Temp.	Sp. Gr.	Temp.	Sp. Gr.	Temp.	Sp. Gr.
January	1	...	5.2	27.2	...	...	5.9	27.2
"	2	...	4.8	27.2	...	...	5.6	27.2
"	3	...	5.0	27.6	...	...	6.7	27.0
"	4	...	5.2	27.5	...	...	6.7	27.4
"	5	...	5.3	27.4	...	...	6.4	27.6
"	6	...	5.3	27.4	...	...	6.3	27.5
"	7	...	4.8	27.7	...	...	4.8	27.6
"	8	...	...	...	...	...	...	...
"	9	...	4.7	27.6	...	...	6.0	27.6
"	10	...	4.3	27.9	...	...	...	...
"	11	...	4.7	27.9	...	...	6.8	27.7
"	12	...	4.2	27.6	...	...	...	...
"	13	...	3.6	27.9	...	...	...	...
"	14	...	3.8	27.9	...	...	...	...
"	15	...	...	...	...	...	...	...
"	16	...	2.8	28.0	...	...	5.2	27.2
"	17	...	3.0	27.9	...	...	5.7	27.5
"	18	...	3.3	27.6	...	...	5.7	27.6
"	19	...	3.4	27.7	...	...	5.1	27.7
"	20	{ A few hundred. }	3.5	27.8	...	...	5.2	27.7
"	21	...	4.0	27.5	...	...	5.8	27.5
"	22	40,000	...	...	...	...	...	...
"	23	40,000	3.8	27.8	...	...	5.2	27.6
"	24	40,000	4.4	27.7	...	...	5.1	27.4
"	25	80,000	4.1	27.8	...	...	4.9	27.3
"	26	160,000	3.6	27.8	...	...	4.7	27.6
"	27	160,000	3.7	27.7	...	...	4.2	27.4
"	28	80,000	4.7	27.7	...	...	...	...
"	29	...	...	...	...	...	...	...
"	30	320,000	4.9	27.9	...	...	5.8	26.9
"	31	160,000	4.2	27.7	...	...	...	27.5
February	1	200,000	3.9	27.7	4.4	27.8	4.0	27.6
"	2	120,000	3.3	27.8	3.7	27.6	3.9	27.8
"	3	320,000	3.0	27.9	2.7	27.7	4.4	27.7
"	4	180,000	3.2	27.8	4.7	27.6	5.6	27.8
"	5	...	...	...	...	...	...	...
"	6	200,000	4.8	27.6	6.0	27.8	...	...
"	7	320,000	4.2	27.6	4.8	27.7	5.0	27.5
"	8	160,000	4.0	27.6	4.4	27.7	4.2	27.5
"	9	200,000	4.9	27.5	5.4	27.6	5.2	27.4
"	10	280,000	4.4	27.5	5.0	27.6	5.2	27.5
"	11	200,000	3.2	27.6	2.8	27.7	4.0	27.7
"	12	...	...	...	...	...	...	...
"	13	200,000	...	...	...	...	...	...
"	14	580,000	3.4	27.8	5.7	27.2	...	...
"	15	480,000	3.8	27.6	5.6	27.3	5.6	26.7
"	16	280,000	4.4	27.6	6.1	27.3	...	...
"	17	580,000	4.2	27.7	5.1	27.6	4.9	27.8
"	18	336,000	4.8	27.9	6.2	27.5	5.8	27.8
"	19	...	...	...	...	...	...	...
"	20	732,000	3.3	27.8	2.8	27.8	...	...
"	21	904,000	3.2	27.8	3.2	27.7	4.2	27.1
"	22	237,000	3.4	27.5	3.5	27.4	...	...
"	23	237,000	3.5	27.6	3.4	27.7	...	...
"	24	430,000	3.6	27.6	3.9	27.8	...	...



TABLE I.—continued.

Date.	Eggs Collected.	Eggs Dead.	In Pond.		In Hatchery.		On Beach.	
			Temp.	Sp. Gr.	Temp.	Sp. Gr.	Temp.	Sp. Gr.
February 25	560,000	...	3·7	27·6	4·5	27·3	...	...
" 26	...	...	...	...	...	...	...	...
" 27	646,000	1,163,000	3·6	27·5	4·6	27·3	...	...
" 28	860,000	...	3·6	27·7	4·8	27·4	...	...
March 1	603,000	...	4·1	27·3	5·0	27·0	5·2	24·3
" 2	495,000	...	4·1	27·2	4·8	26·8	5·1	27·1
" 3	474,000	...	3·8	27·2	3·8	27·2	4·6	27·5
" 4	689,000	...	4·3	27·0	4·7	27·	5·0	27·7
" 5	...	...	...	...	...	...	...	...
" 6	947,000	...	...	...	...	...	...	...
" 7	1,034,000	...	4·3	27·3	4·6	27·4	5·1	27·6
" 8	560,000	1,077,000	4·2	27·4	4·8	27·3	5·2	27·6
" 9	560,000	...	3·3	27·3	4·4	27·4	4·8	27·2
" 10	517,000	...	3·8	27·5	4·2	27·4	...	...
" 11	...	...	...	...	...	...	...	...
" 12	...	...	...	...	...	...	...	...
" 13	1,679,000	...	4·6	27·2	4·9	27·2	...	...
" 14	603,000	...	5·0	27·2	5·6	27·2	...	...
" 15	689,000	...	5·1	27·1	5·6	27·6	...	...
" 16	711,000	1,391,000	...	...	...	...	...	...
" 17	1,301,000	...	5·6	27·2	5·8	27·6	5·6	27·1
" 18	560,000	...	...	...	...	...	...	...
" 19	...	...	...	...	...	...	...	...
" 20	1,077,000	...	5·4	27·2	5·7	27·1	5·6	27·3
" 21	646,000	...	5·6	27·2	5·7	27·2	5·6	27·6
" 22	646,000	1,390,000	6·0	27·3	6·2	27·4	5·8	27·6
" 23	904,000	...	6·2	27·4	6·2	27·4	5·9	27·4
" 24	646,000	...	5·9	27·3	5·8	27·5	5·9	26·5
" 25	775,000	...	...	...	...	...	...	...
" 26	...	...	...	...	...	...	...	...
" 27	775,000	...	...	...	...	...	...	...
" 28	517,000	1,785,000	...	...	...	...	...	...
" 29	474,000	...	...	...	...	...	...	...
" 30	947,000	...	...	...	...	...	...	...
" 31	646,000	...	6·6	27·2	6·6	27·4	...	...
April 1	732,000	...	6·2	27·2	5·9	27·6	...	...
" 2	...	...	...	...	...	...	...	...
" 3	947,000	2,088,000	6·5	27·2	6·7	27·6	6·7	27·4
" 4	689,000	...	7·1	27·5	7·4	27·4	8·0	27·3
" 5	517,000	...	6·8	27·3	6·4	27·4	...	...
" 6	646,000	...	5·8	27·3	5·6	27·5	5·4	27·5
" 7	560,000	...	5·2	27·4	5·4	27·4	4·6	26·7
" 8	474,000	...	...	...	...	...	...	...
" 9	...	...	...	...	...	...	...	...
" 10	603,000	...	4·9	27·6	5·6	27·4	6·4	27·4
" 11	517,000	...	5·5	27·3	5·7	26·9	6·2	27·5
" 12	301,000	...	5·8	27·4	6·4	26·9	6·4	27·3
" 13	...	...	6·0	27·1	6·4	26·5	...	...
" 14	517,000	2,303,000	6·3	27·1	6·5	26·9	...	...
" 15	845,000	...	...	...	...	...	...	...
" 16	...	...	...	...	...	...	...	...
" 17	517,000	...	6·2	26·9	6·2	26·8	6·2	26·6
" 18	474,000	...	6·0	27·0	5·9	27·1	6·1	27·0
" 19	215,000	...	6·4	26·5	6·6	26·1	6·4	26·1
" 20	258,000	...	6·5	26·6	6·7	26·1	6·8	26·4
" 21	215,000	...	6·2	26·7	5·8	26·5	6·2	26·4
" 22	215,000	...	6·5	26·4	6·1	26·6	6·6	26·6

TABLE I.—continued.

Date.	Eggs Collected.	Eggs Dead.	In Pond.		In Hatchery.		On Beach.	
			Temp.	Sp. Gr.	Temp.	Sp. Gr.	Temp.	Sp. Gr.
April 23	...	...	...	...	...	...	...	...
" 24	...	...	6·4	26·8	6·3	26·8	...	...
" 25	...	...	6·5	26·7	6·8	26·6	6·5	27·4
" 26	...	...	6·7	26·6	6·6	26·9	8·9	27·1
" 27	259,000	...	7·1	26·6	7·7	26·8	...	...
" 28	172,000	...	7·5	26·8	7·6	26·9	7·2	24·7
" 29	258,000	...	7·7	26·9	7·4	26·7	6·9	26·5
" 30	...	2,195,000	...	...	...	...	...	...
May 1	108,000	...	8·2	26·2	7·6	25·3	7·6	25·8
" 2	...	...	8·0	26·3	7·4	26·8	7·4	26·5
" 3	258,000	...	8·2	26·3	7·8	27·3	8·2	26·3
" 4	...	...	8·4	26·5	8·2	26·8	7·0	26·9
" 5	260,000	...	8·4	26·7	9·2	26·9	8·0	27·2
" 6	85,000	...	8·8	26·8	9·4	27·0	8·4	27·0
" 7	...	...	...	...	...	...	...	...
" 8	85,000	...	9·6	26·4	9·6	26·1	8·2	27·0
" 9	...	...	9·6	26·8	9·2	27·2	...	...
" 10	...	...	9·8	26·7	9·8	27·1	8·4	27·3
" 11	86,000	1,301,000	10·4	26·6	10·2	26·8	9·0	27·3
" 12	...	...	10·2	26·7	9·6	26·4	9·2	27·1
" 13	...	...	...	...	...	...	...	...
" 14	...	...	...	...	...	...	...	...
" 15	...	...	10·6	26·9	9·8	27·0	9·3	27·1
" 16	A few hundred.	...	9·8	27·2	10·6	26·6	9·8	27·1
" 17		...	9·8	27·2	10·0	26·6	9·5	27·4
" 18		...	10·4	26·4	10·0	26·8	9·5	26·3
" 19		...	10·6	26·5	11·0	26·6	9·2	26·9
" 20		...	10·3	26·8	10·2	26·9	9·2	26·3
Totals,	40,110,000	15,791,000						

During the spring just passed, delegations of fishermen from Elginshire, Caithness, Argyle, and Bute and Arran attended the demonstrations at the hatchery, and expressed themselves as pleased and instructed by what they learnt. I am indebted to Dr. Williamson for taking the photographs which are reproduced in the accompanying plates.



FIG. 1.



FIG. 2.





FIG 1

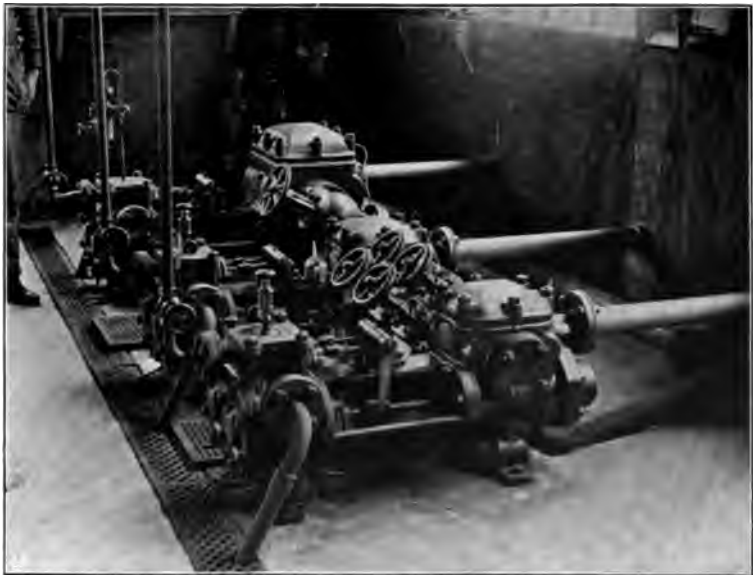


FIG. 2





TABLE II.—Showing Particulars in connection with the Distribution of the Fry.

Date.	Locality.	Depth.	Temperature	Surface Water.		Weather.	Estimated number of fry put out.
				Specific Gravity.	Temperature.		
8th Mar.	About $\frac{1}{2}$ -mile off Bay of Nigg, - -	14	F. 41·4	28·2	40·6	...	1,055,000
20th „	Two miles East of mouth of Don -	17	41·7	27·4	42·8	Overcast,	2,930,000
29th „	Off Girdleness, - -	7	42·4	27·6	45·1	Sunshine,	3,518,000
5th April	Off Girdleness, - -	7 $\frac{1}{2}$	42·1	27·2	40·8	N.-W. wind, snow,	2,931,000
24th „	Off St. Combs, - -	...	...	...	...	...	3,517,000
4th May	Off mouth of Don, -	12	45·3	26·9	48·9	...	2,344,000
10th „	Off mouth of Don, -	10	44·8	27·4	51·8	...	4,689,000
23rd „	Off Girdleness, - -	13	47·1	27·0	50·9	...	3,516,000
							24,500,000

## DESCRIPTION OF PLATES.

### PLATE VI.

- Fig. 1. View of the outside of the Hatchery from the landward side. (a) Storage tank or reservoir; (b) corner of pump-house; (c) store-house.  
 Fig. 2. View of the large spawning pond and laboratory. (a) Laboratory; (b) valve; (c) tank-house; (d) marks the place where the inflow pipe enters; (e) pipe supplying the tank-house.

### PLATE VII.

- Fig. 1. View of the inside of the hatching room, showing the hatching apparatus on each side.  
 Fig. 2. View of the sea-water pumps and their connections.

V.—ON THE SPECIFIC CHARACTERS OF *GADUS LUSCUS*,  
*GADUS MINUTUS*, and *GADUS ESMARKII*.

By H. CHARLES WILLIAMSON, M.A., D. Sc., Marine Laboratory,  
Aberdeen.

(Plates VIII.—X.)

CONTENTS.

	PAGE.
Introduction, . . . . .	116
List of Body-Dimensions, . . . . .	119
List of Enumeration-Characters, . . . . .	121
Discussion of the Averages, . . . . .	121
The Numbers of Fin-rays, . . . . .	124
The Numbers of Vertebrae, . . . . .	129
The Reproduction of the Three Species, . . . . .	130
The Skulls of the Three Species, . . . . .	131
A Discussion of the Species, . . . . .	133
A Specific Description, . . . . .	135
The Diagnosis of a Species, . . . . .	136
General Appearance of the Three Species, . . . . .	136
Key, . . . . .	138
Literature, . . . . .	139
List of Tables, . . . . .	141
Tables, . . . . .	142-158

INTRODUCTION.

The present research is a continuation of the paper contributed to the *Twentieth Annual Report of the Fishery Board for Scotland*, Part III., entitled, "A comparison between the cod (*Gadus callarias*), the saithe (*Gadus virens*), and the lythe (*Gadus pollachius*) in respect to certain external and osteological characters." In that paper a beginning was made with the review of the species of the genus *Gadus*. In several instances the accepted specific descriptions are unsatisfactory; so much so is this the case that difficulty is experienced in separating certain species. A certain amount of confusion has existed in the diagnosis of *G. luscus* and *G. minutus*; and the third species, *G. esmarkii*, which has, through Dr. Fulton's trawling experiments, been shown to be common in Scottish waters, might in its smaller stages be mistaken for a young *minutus*. The three species under review are the three smallest species of the genus; in the former paper the three largest members were dealt with. A systematic study of the three forms has become necessary in order to definitely fix the specific characters. It is very seldom that a single member of a species will exhibit all the distinguishing characters well. It has thus been necessary to examine a considerable number of specimens of each species. The main purpose is to arrive at an accurate and suitable specific description, and with this end in view, both the characters in which they agree, as well as those wherein they differ, must be studied. A minute comparison is therefore instituted between the three forms, and by the method which was adopted in the previous research. The method has been to make a number of measurements on the body of the fish, in order to determine the comparative magnitude of corresponding distances



on specimens of each species, and also to determine to what extent the dimensions vary in the same species. The number of fin-rays in the unpaired fins and the number of vertebrae formed the basis of comparison. In the selection of the measurements a wide choice exists. It is important to have measurements and characters in which the different forms agree accurately defined. Such characters should not be included in the specific description; they belong to the sub-genus. The introduction into a specific description of the relation between the sizes of two characters, both of which do not lend themselves to accurate definition, should be avoided.

There are certain characters selected, to which one is guided by the general appearance of the fish. A glance at the forms when compared side by side will often indicate possible specific differences. These points of difference sometimes vanish when a number of fishes have been examined; they may be found to be peculiar, individual, and not specific. Many and varied characters may be from time to time adopted, to be dropped again on account of the difficulty of suitably measuring the quantities.

Most of the measurements which were made will be discussed in detail. The values of such characters for specific distinction is in that way determined.

All the measurements have been expressed in terms of the length of the fish.

#### THE FISHES EXAMINED.

All the fishes which have been studied for the purpose of this research were obtained in the North Sea, with the exception of 4 specimens of *Gadus minutus* which were kindly sent from Plymouth\* by Dr. H. M. Kyle. The specimens of *luscus* and *minutus* were got chiefly in the neighbourhood of Aberdeen. The *G. esmarkii* were obtained during Dr. Fulton's trawling investigations in the North Sea. Some were obtained off Aberdeen and in the Moray Firth, others were captured in the vicinity of the Shetland Islands. The *esmarkii* were got in the small-meshed cod-end with which the ordinary trawl was covered. The *luscus* and *minutus* were taken in the ordinary trawl.

*Luscus* and *minutus* are often confused, and are known collectively under the names "Brassies," "Miller's Thooms," "Skelchies," "Davies," etc. They were obtained on or near hard ground within a radius of 25 miles from Aberdeen. *Luscus* was obtained on one occasion in quantity at a point 6 miles E.S.E. of Cruden Scaurs, Aberdeenshire. Out of 38 brassies, 36 were *luscus* and 2 *minutus*. Usually only an odd example of *luscus* was obtained among frequent little lots of *minutus*. *Luscus* and *minutus* are frequently got on the haddock lines, but only in small numbers. On 11th June, 1906, one *luscus*, and four *minutus* were caught on a haddock line near Aberdeen.

In the following Table are set out the various points at which *luscus* and *minutus* appeared among the fishes taken in the trawl of the s.s. "Fifeness," Aberdeen, during the spring of 1905.

\* These were 4 females measuring 11, 11·3, 11·4 and 16·6cm. respectively.

[TABLE.

Locality.	Date.	<i>Luscus.</i>	<i>Minutus.</i>
Vicinity of Aberdeen ... ..	December 16, 1904,	1	2
14 Miles E. by N. of Aberdeen...	" 21, "	1	4
14 Miles E. by S. " ...	January 11, 1905,	3	4
16 Miles S.E. " ...	" 12, "	...	2
4½ Miles S.E. " ...	" 14, "	1	17
10 Miles off Aberdeen ...	" 19, "	2	1
4½-10 Miles S.E. of Aberdeen ...	" 21, "	3	6
6 Miles E.S.E. of Cruden Scaurs, Aberdeenshire ... ..	" 23, "	36	2
20 Miles S.E. of Aberdeen ...	" 27, "	1	35
21 Miles E. by S. of Aberdeen...	February 3, "	1	14
6 Miles E. of Aberdeen ...	" 11, "	6	3
20-25 Miles S.E. of Aberdeen ...	" 16, "	...	67
21 Miles E.S.E. of Aberdeen, 41-50 fms. ... ..	March 9, "	2	18
Vicinity of Aberdeen ... ..	" 14, "	...	27
" " ... ..	" 31, "	...	25
" " ... ..	May 13, "	...	29
" " ... ..	" 27, "	1	21

A proportion of the above specimens of *luscus* and *minutus* species was examined fresh; the majority were, however, examined some time after being preserved in formaline solution—a 2½ per cent. solution of formaline in fresh water.

All the specimens of *esmarkii*, with three exceptions, had been preserved from two to five years, in formaline solution mainly; some were preserved in alcohol.

The following are localities whence came some of the specimens of *esmarkii* which were examined :—

Locality.	Date.	Number of Specimens of <i>Esmarkii</i> .
Moray Firth—off Dunbeath ...	October 10, 1900	9
" " Deep Hole, off Kin- naird Head ... ..	July 4, 1901	10
Moray Firth ... ..	February 7, 1905	1
Off Aberdeen, 65 fms. ... ..	June 28, 1901	7
21 Miles E.S.E. of Aberdeen ...	March 9, 1905	2
Between Orkney and Shetland Is.	October, 1900	17

The sizes and sex of all the fishes examined are shown in the following Table :—

[TABLE.

Length. Cm.	<i>G. Esmarkii.</i>			<i>G. Minutus.</i>			<i>G. Luscus.</i>			Total at Each Size.		
	♂	♀	Sex. ?	♂	♀	Sex. ?	♂	♀	Sex. ?	<i>Esmarkii.</i>	<i>Minutus.</i>	<i>Luscus.</i>
8	...	1	...	...	...	...	...	...	...	1	...	...
9	...	2	...	...	...	...	...	...	...	3	...	...
10	1	...	3	...	...	...	...	...	...	4	...	...
11	5	6	5	...	3	...	...	...	...	16	3	...
12	3	8	2	...	...	...	...	...	...	13	...	...
13	2	3	...	...	...	...	...	...	...	5	...	...
14	4	13	2	...	2	...	...	...	...	19	2	...
15	4	20	...	1	1	...	...	...	...	24	2	...
16	...	12	1	3	3	...	1	...	...	13	6	1
17	1	8	...	6	7	...	...	...	...	9	13	...
18	...	5	1	5	6	...	...	...	...	6	11	...
19	...	3	1	...	11	2	...	...	...	4	20	...
20	...	...	...	8	21	...	...	...	...	...	29	...
21	...	1	...	8	60	2	1	...	...	1	70	1
22	...	...	...	6	69	...	...	...	...	...	75	...
23	...	...	...	...	43	1	...	...	...	...	44	...
24	...	...	...	...	27	1	2	1	...	...	28	3
25	...	...	...	...	16	1	2	1	...	...	17	3
26	...	...	...	...	9	...	5	2	...	...	9	7
27	...	...	...	...	3	...	7	5	1	...	3	13
28	...	...	...	...	...	...	1	6	1	...	...	8
29	...	...	...	...	1	...	1	3	...	...	1	4
30	...	...	...	...	...	...	3	2	...	...	...	5
31	...	...	...	...	...	...	...	2	...	...	...	2
32	...	...	...	...	...	...	...	2	...	...	...	2
33	...	...	...	...	...	...	2	...	...	...	...	2
34	...	...	...	...	...	...	2	...	...	...	...	2
35	...	...	...	...	...	...	1	2	...	...	...	3
36	...	...	...	...	...	...	1	...	...	...	...	1
37-39	...	...	...	...	...	...	...	...	...	...	...	...
40	...	...	...	...	...	...	...	1	...	...	...	1
Total—	...	...	...	...	...	...	...	...	...	118	333	58

# THE BODY DIMENSIONS.

The comparison between the three species is instituted then by means of the following body dimensions:—

THE GIRTH is measured by means of a thread passed round the fish at three points:—(1) *Pectoral Girth*—in the axilla close to the base of the pectoral fin. (2) *Girth at anus*—at the level of the anus. (3) *Girth at the root of the tail*—at the thinnest part of the caudal peduncle, *i.e.*, the part of the tail extending between the end of the third dorsal fin and the beginning of the caudal fin.

DORSO-VENTRAL HEIGHT OF BODY.—This dimension was measured by callipers. For the pectoral height the point of the callipers was put between the bases of the ventral fins, while the other point was made to touch a point in the dorsal line, immediately above. The callipers were made to touch the parts lightly. The other two points were at the level of the anus and on the root of the tail, at the narrowest part.

DIAMETER OF THE EYE.—The diameter of the eye was the horizontal diameter of the orbit.

INTERORBITAL SPACE.—The interorbital space is the distance on the dorsal surface of the head between the orbits.

GREATEST LENGTH OF THE VENTRAL, PECTORAL, AND FIRST DORSAL FINS.—The fin was measured from the base of the first ray, *i.e.*, in the

case of the ventral and pectoral fins the most dorsal ray—in the case of the first dorsal fin, the most anterior ray—to the tip of the longest ray.

**HEIGHT OF THE LATERAL LINE ABOVE THE LATERAL AXIS.**—The lateral axis is here taken as coinciding with the straight posterior part of the lateral line. This line was continued by a thread on the measuring board along the fish, and the interval between it and the lateral line was measured at two points—viz., at the level of the anus and at the level of the base of the pectoral fin. In *luscus*, in place of the measurement at the pectoral fin, which is very close to the anus, a new point at the middle of the first dorsal fin was chosen.

**LENGTH OF THE RAMI OF TAIL-FIN.**—That is, the distance from the base of the first fin-rays of the caudal fin on the dorsal or ventral line of the body to the tip of the ramus of the tail.

**THE SPREAD OF THE TAIL.**—The greatest breadth of the tail-fin. For the purpose of this measurement it is not spread out to its fullest extent, but is allowed to fall on the table.

**LENGTH OF THE CAUDAL PEDUNCLE: dorsal.**—The part of the dorsal edge between the end of the third dorsal fin and the beginning of the caudal fin.

**GREATEST HEIGHT OF THE UNPAIRED FINS.**—The fin is stretched out, and its greatest breadth is measured, *i.e.*, between the base and the highest point vertically above the base. This is a character which it is often impossible to get, owing to the fact that in trawled fish the fins are usually frayed or broken.

The above measurements of the eye, interorbital space, of the fins, and of the height of the lateral line were made by means of dividers.

**THE DISTANCE OF DIFFERENT POINTS FROM THE ANTERIOR TIP OF THE FISH.**—The anterior tip of the fish is in *luscus* and *minutus* the tip of the upper jaw, in *esmarkii* the tip of the lower jaw. The distance of each point was measured as projected on the lateral axis. The lateral axis is the line joining the anterior tip to the middle rays of the tail-fin.

These points are :—

Anterior edge of the orbit (for the length of the snout).

The base of the first fin-ray of the ventral fin.

The base of the first fin-ray of the pectoral fin.

The opercular cleft.

The hindmost part of the edge of the operculum.

The anus.

Beginning and end of each of the unpaired fins.

Beginning of the caudal fin, dorsal and ventral.

Tip of the ramus of tail, dorsal and ventral.

Point where the lateral line begins to rise up off the horizontal—the anterior end of the straight part of the lateral line.

The beginnings of the fins were marked by means of pins inserted at the base of the first ray. A pin inserted in the anus was taken as the position of the anus. A pin lying in the opercular cleft indicated that point.

For the purpose of these measurements a measuring board, similar to that which was used during the research on the "Mackerel of the East and West Coasts of Scotland" (*Eighteenth Annual Report of the Fishery Board for Scotland*, Part III., p. 295), was employed. The measurements made on the soft body of the fish are not such as permit of exact determination, and probably the errors due to the want of rigidity is greater in small fish than in large specimens. There is, however,

greater accuracy to be obtained on the whole by making the measurements on such a board as described in the 18th Report, than by merely stepping off the distances on the fish with a pair of dividers. If the fish are in good condition, in both methods greater accuracy will be obtainable than in specially soft specimens.

The measurements were made in *centimetres*.

*The Measurements Represented as Percentages of one Common Standard.*—All the body dimensions were converted into percentages of one standard, viz., the length of the fish.

THE LENGTH OF THE FISH is the distance from the anterior tip (premaxilla or mandible, as the case may be) to the end of the middle rays of the tail fin.

The fishes of each species have been arranged in centimetre groups. The *average* of the percentages of the length of the fish which each body dimension was found to represent was calculated for the fishes of each size. They have been arranged in Tables VII, VIII, IX, X, XI, XII. Alongside each average is added in brackets the number of fishes on which the average is based.

The average percentage for each character has then been calculated in all the fishes of each species in which the character was noted. The number of characters examined in each specimen varied very much; while in some all the characters were noted, in others one or two characters were measured.

#### *Enumeration-Characters.*

THE NUMBER OF RAYS IN THE UNPAIRED FINS.—The enumeration of the fin-rays is rendered difficult from the fact that we are dealing with small fishes. The last rays in the fins with the exception of the first dorsal are minute. The first rays of the first anal fin are sometimes liable to be missed on account of their very small size.

In a few cases the number of rays in the paired fins and the caudal fin was counted.

THE NUMBER OF VERTEBRÆ.—The number of vertebræ was counted after the fish had been boiled. The posterior vertebræ are very small; the backbone tapers down to a fine extremity. The vertebræ are not so easily counted in preserved fishes as in fresh specimens. A fish that has been preserved in formaline solution, when boiled, usually becomes distorted. This is due to unequal shrinkage; the skin is much affected in this respect, becoming very tough. The vertebra bearing the ural elements is counted as the last vertebra.

THE NUMBER OF THE VERTEBRA BEARING THE FIRST HÆMAL ARCH.—This character was noted in a number of instances.

#### DISCUSSION OF THE BODY DIMENSIONS.

The averages taken along with the range of variation of the character gives a more or less partial view of the species. By a comparison between the species we shall be able to see in how far any of these dimensions is of specific value. If we find that the ranges of variation in two species overlap for any one character, that character cannot be regarded as of primary rank in a specific description. In a dimension of which the ranges of variation do not overlap in two species we have a character of primary rank. The characters as set out in Table XIII. will now be examined in detail.

In respect to the *Girth*, a character in which there is a wide difference existing among the three species, so far as the eye can judge, we find a distinct enough separation between certain of the species. At the pectoral region *luscus* has a girth equal on the average to 60 per cent. of the length of the fish, thus exceeding by a considerable amount the respective girth in *minutus* and *esmarkii*. And since the range of variation in *luscus* does not overlap that of *esmarkii* the difference in the girth is of some specific value. The ranges of variation in *luscus* and *minutus* meet though they do not overlap, and between these two the character is of more or less negative value. *Minutus* and *esmarkii* overlap in their ranges of variation and this character is not therefore of value. At the anus, the girths in the three species increase a little. The girth of *minutus* now overlaps that of *luscus*. In the girth at the root of the tail, where a considerable difference exists between *minutus* and *luscus*, judging by the eye, a small difference only is shown by the percentages, but a complete separation is seen between *luscus* and *esmarkii* in respect to this character. The dorso-ventral height of the body agrees closely with the girth relations.

In all three species the horizontal diameter of the eye is on the average as great or greater than the length of the snout, i.e., the distance from the tip of the jaws to the anterior edge of the orbit. *Luscus* has a distinctly smaller eye than *minutus* and *esmarkii*—which two agree exactly—but complete separation in this character does not hold between any two of the species. In the size of the interorbital space the reverse relation is seen, *luscus* having a larger average than the other two, in which there is equality. By their variation, however, they merge into one another.

In the matter of the lengths of the ventral, pectoral, and first dorsal fins, although very distinct agreements and differences are shown in the averages, still the latter are so small that they are really of no specific value. Thus in *minutus* and *esmarkii* the average size of the ventral fin is the same, while that of *luscus* is a little larger; whereas in the case of the pectoral fin, *luscus* and *esmarkii* agree closely and have a fin a little longer than *minutus*. The first dorsal fin is on the average rather larger in *luscus* than in *minutus*, but the two ranges of variation overlap. This character was not noted in *esmarkii*.

In the following characters—height of the lateral line above the lateral axis, the length of the rami of the tail, and the spread of the tail, the greatest height of the unpaired fins—only a few observations were made.

*Luscus* shows a considerably higher bend in the lateral line than *esmarkii*, and a little higher than *minutus*.

The lengths of the rami of the tail of the three forms agree closely, but in the spread of the tail *luscus* and *minutus* exceed *esmarkii*, being on the average half as broad again as the latter.

The length of the barbel was in *esmarkii* on the average 3 per cent. of the length of the fish; in one specimen of *minutus* the barbel was 5 per cent. of the same quantity.

*Distances from the Anterior Tip of the Body.*—The average for the length of the snout, i.e., the distance of the anterior border of the orbit from the tip of the jaws, is the same in *luscus* and *minutus*, and 1 per cent. over that in *esmarkii*; but in the latter the snout is measured from the tip of the mandible, which projects on the average 1 per cent. in front of the premaxilla. When that amount is subtracted we get an equal average measurement for the snout in all three.

The ventral fin is situated nearest the tip of the jaws in *luscus*, next in *minutus*, and farthest back in *esmarkii*. The ranges of variation of the

first and the last meet but do not overlap; they each overlap the range of variation of this character in *minutus*. In the distance of the opercular cleft from the anterior end of the body we obtain the same average in each species, and in respect to the hind edge of the operculum, while the averages differ to the extent of 2 per cent. between *minutus* and *esmarkii*, each of these differs from *luscus* by 1 per cent. only.

The position of the pectoral fin is practically the same in all three species in respect to the distance of the base of the first fin-ray from the anterior end of the fish. The distance of the anus from the snout is a diagnostic difference between *luscus* and *minutus*. In the average, the position is at 26 per cent. in the former and at 32 at the latter; the ranges of variation do not overlap. In *esmarkii* the anus is on the whole slightly farther back than in *minutus*, with, of course, a correspondingly greater divergence from *luscus*. Between *esmarkii* and *minutus* the ranges of variation overlap.

In the position of the first dorsal fin, there is very close agreement, and overlapping.

In the second dorsal fin all three overlap, both in respect to the point at which the fin begins, and also in the position of the end of the fin. *Luscus* and *minutus* have a longer fin-base than *esmarkii*.

In respect to the beginning of the third dorsal fin, they are all equal, but as *luscus* has a shorter fin-base than the two others—the fin ends in it a little farther anteriorly than in the other two.

The first anal fin commences close behind the anus; it ends first in *esmarkii*, and then a little distance farther posteriorly in *minutus* and *luscus*.

In the matter of the second anal all three species agree, both in its commencement and its end.

The caudal peduncle is on the average smaller in *luscus* than in *esmarkii* and *minutus*, but the ranges of variation overlap.

The bend in the lateral line rises farther back in *luscus* than in the other two. It is usually just behind the middle of the length of the body; in no case in *luscus* did it commence on the anterior half of the body; in *minutus* and *esmarkii* it did in some cases begin just on the anterior side of the middle of the body. The lateral line rises more rapidly in *luscus* than in *minutus* and *esmarkii*.

The general relation between the three forms in respect to the different characters selected has been briefly discussed, but these relationships expressed in this form are of themselves of no value from the point of view of specific description. These characters may and do indicate where specific characters may be found. For a specific description it is necessary that the selected characters be tested on one fish. A specific character which infers comparison with a fish of another species is of only secondary value. Each character must be expressed in terms of the individual fish. The size of the eye, for example, may be of specific value when it is stated in terms of the length of the snout, or of any other part of the fish, while it is of no value when compared to the size of the eye in another species.

The position of the anus is a very good guide in diagnosing certain species, and it is important in the present case. The form in which it is represented in the Tables, as being situated at a certain percentage of the length of the fish from the tip of the jaws, is not a useful one for a specific description. It should be expressed in a relationship that is more readily measured, and for this the relation between the position of the anus and the situation of the first dorsal fin. Now, an examination of the measurements of the distance of the two points shows

that among specimens of *luscus* the anus was situated exactly below the beginning of the first dorsal in three cases; in two cases it was in front of that point to the extent of 1 per cent. of the length of the fish, and in seven cases it was behind the beginning of the first dorsal to the extent of 2 per cent. of the fishes' length.

In *luscus*, then, the anus is situated below the beginning of the first dorsal fin.

In *minutus* the anus occupies a very different position in relation to the first dorsal fin. Of 34 examples of *minutus*, in 31 the anus was below the second half of the first dorsal, in one case it was below the middle point of the fin, and in two cases it was just in front of the middle point to the extent of 1 per cent. of the length of the fish. In *minutus*, therefore, the anus is under the second half of the first dorsal fin, i.e., from the middle of the fin to the hind limit of its base. The amount by which the anus was in front of the middle point of the fin would not be noticeable to the eye, and for all practical purposes it would be regarded as coinciding with the middle point.

In *esmarkii* the anus is below the second half of the first dorsal fin; this was found to be the case in all the fishes in which these characters had been recorded—viz., 56 in number. In one of these the anus was exactly below the end point of the fin-base. In *esmarkii*, then, the anus is situated below the second half of the first dorsal fin.

The comparative depth of the members of the two species, *luscus* and *minutus*, has been insisted on in a specific description. It is not, however, very easy to reduce this relation to a specific character. In some specimens it is well marked; but while *luscus* is always a deep fish, *minutus* is variable in this respect. Sometimes in a collection of *minutus* it is possible to divide them up into two lots differing markedly in the depth of body, and in the deeper lot simulating in depth *luscus*. It is necessary to know the range of variation in this character as determined by the measurements of various examples. If, therefore, we examine the average dorso-ventral height of each species, as set out in Table XIII, we find the average height at the anus is, for *luscus*, 26 per cent; for *minutus*, 21 per cent.; and for *esmarkii*, 18 per cent. of the length of the fish. In *luscus*, however, the depth ranges from 28 per cent. to 22 per cent., while in *minutus* the limits were 24 per cent. and 18 per cent. The relation between the two species might be summarised thus:—Where the dorso-ventral height reaches one-quarter or more of the length of the fish, we have to deal with *luscus*; where the same character is as small as one-fifth or less of the length, the fish is probably *minutus* or *esmarkii*; but where the relation lies between one-quarter and one-fifth, either of the two first species may be represented. It is evident, then, that a character such as this is only of small importance for specific diagnosis.

#### *The Lengths of the Bases of the Unpaired Fins.*

The inter-relations of the sizes of the different fin-bases may be here considered. In the following Table the average size of the fin-base, expressed as a percentage of the length of the fish, and its range of variation is given for each of the three species.

Species.	1 D.				2 D.				3 D.			
	Max.	Av.	Vari- ants.	Min.	Max.	Av.	Vari- ants.	Min.	Max.	Av.	Vari- ants.	Min.
<i>G. luscus</i>	13	11.6	10	10	27	25	10	24	15	12.7	10	11
<i>G. minutus</i>	13	11.2	34	10	26	24.3	33	22	17	15.2	34	13
<i>G. esmarkii</i>	15	12	56	9	25	22	48	20	18	16.5	47	12



Species.	1 A.				2 A.			
	Max.	Av.	Vari- ants	Min.	Max.	Av.	Vari- ants.	Min.
<i>G. luscus</i>	45	39·8	40	37	17	15	45	12
<i>G. minutus</i>	35	31	42	28	18	15·5	34	13
<i>G. esmarkii</i>	31	27·7	71	25	19	16·7	47	14

The base of the first anal fin is measured from the hind edge of the anus to the end of the base of the fin.

Various relationships between the lengths of the fin-bases may be made out by inspection of the averages. Take, for example, the ratio between the lengths of the anal fins :—

In *luscus* the first anal bears to the second anal the ratio of 40 : 15, *i.e.*, 8 : 3.

In *minutus* the corresponding ratio is 31 : 15·5, *i.e.*, 2 : 1.

In *esmarkii* the corresponding ratio is 28 : 17, *i.e.*, 5 : 3.

From these data, then, it might be expected that a specific character could be obtained in the relation between the two anal fins. To test its value from the point of view of specific description it is necessary to find what ratios are found in a number of fish. These are set out below. The various ratios found existing between the anal fins in respect to the length of their bases is set out for each species, and the frequency with which each occurred in the sample of fish is also added.

Ratios of the First Anal to the Second Anal Fin.	Frequency in <i>G. luscus</i> .	Frequency in <i>G. minutus</i> .	Frequency in <i>G. esmarkii</i> .
3·3 : 1	1	..	..
3·2 : 1	..	..	..
3·1 : 1	1	..	..
3 : 1	2	..	..
2·9 : 1	2	..	..
2·8 : 1	4	..	..
2·7 : 1	7	..	..
2·6 : 1	6	..	..
2·5 : 1	12	1	..
2·4 : 1	4	..	..
2·3 : 1	1	1	..
2·2 : 1	3	4	..
2·1 : 1	1	3	..
2 : 1	..	8	1
1·9 : 1	..	6	3
1·8 : 1	..	7	9
1·7 : 1	..	3	7
1·6 : 1	..	..	8
1·5 : 1	..	..	13
1·4 : 1	..	..	4
1·3 : 1	..	..	2
Total	44	33	47

The extensive overlapping between *luscus* and *minutus* and between *minutus* and *esmarkii* renders this character of value only as a distinguishing feature between *luscus* and *esmarkii*. In *luscus* the first anal is always more than twice as long as the second anal; in *esmarkii* it is usually less than twice the length of the second anal.

The above is the most promising relationship between the lengths of the fin-bases in any of the species.

The three species agree fairly closely in the lengths of the dorsal fins, but show wide diversity in the lengths of the anal fins. If we add the bases of the fins of each species together, keeping the dorsal and anal groups separate, the relations will be seen more easily.

Species.	Sum of Bases of Dorsal Fins (Average Sizes).	Sum of Bases of Anal Fins (Average Sizes).
<i>G. luscus</i> , . . .	49.3	54.8
<i>G. minutus</i> , . . .	50.7	46.5
<i>G. esmarkii</i> , . . .	50.5	44.4

In each species a portion of the dorsal edge equal to half the length of the fish bears fin-rays. On the anal edge the size of the fin-bearing part varies with the species.

#### *The Number of Rays in the Unpaired Fins.*

In the accompanying Table are arranged the average, maximum and minimum number of rays found for each fin. A detailed analysis of the numbers of fin-rays in each fish is given in Tables I, II, III. The range of variation in each species is shown in Table V.

Species.	1 D.			2 D.			3 D.			1 A.			2 A.		
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
<i>G. luscus</i>	15	13.5	12	26	23	21	22	20	18	36	34	31	22	21	18
<i>G. minutus</i>	15	13	11	26	23	20	23	21	19	31	28	26	23	22	20
<i>G. esmarkii</i>	18	15	14	29	25	21	29	26	23	32	29	24	30	27	24

In respect of the first dorsal, *luscus* and *minutus* agree closely both in average, 13, and in the range of variation, 15-11. *Esmarkii* has a larger number of rays, viz., 15 on the average, with a maximum and minimum of 18 and 15 rays respectively.

In the second dorsal the two former species are again almost identical with an average of 23, while *esmarkii* has an average of 25.

The close agreement persists between *luscus* and *minutus* in the third dorsal also, *esmarkii* having in this fin also a higher average.

The first anal, however, brings about a separation between *luscus* and *minutus*; this was, of course, apparent also when the length of the fin-bases were discussed. *Luscus* has 34 fin-rays, and *minutus* 28 rays in the fin, while *esmarkii* approaches the latter closely, having an average of 29.

In the second anal *luscus* and *minutus* are again in close agreement with averages of 21 and 22 respectively, while *esmarkii* shows an average of 27 rays.

*Esmarkii* has a much larger number of fin-rays than either *luscus* or *minutus*.

The average number of fin-rays in all three dorsals is, for *luscus* 56; *minutus*, 57; and *esmarkii*, 66.

It was noticed above that the extent of the dorsal edge which bore fin-rays was the same in all three species. It therefore follows that in *esmarkii* we have to deal with a rather lighter and less robust ray than in the two others.

The anal rays (first and second) amount to 55 in the case of *luscus*, 50 in *minutus*, and 56 in *esmarkii*. Here *luscus* has a total of 55 rays distributed on a portion of the ventral edge equal to 50 per cent. of the length of the fish, while *minutus* has 50 rays on 46 per cent. of the length, and *esmarkii* has 56 rays on a part equal to 45 per cent. of the length of the fish. In the anal fin-bearing part we have in *esmarkii* a greater number of rays to the unit of length than in *luscus* and *minutus*.

If, now, we divide the average length of the fin-base by the average number of rays we shall get a relative index of the robustness of the fin-rays in the different species, and in the different fins of the same species.

Average Index of Fin-rays for each Fin.

Species.	1 D.	2 D.	3 D.	1 A.	2 A.
<i>G. luscus</i> , ...	·8	1·07	·65	1·17	·71
<i>G. minutus</i> , ...	·84	1·04	·71	1·1	·7
<i>G. esmarkii</i> , ...	·8	·88	·63	·96	·63

The index of the fin-ray of *esmarkii* is smaller than those of *luscus* and *minutus*, in all the fins except the first. There is also to be noticed that in each species the indices of the third dorsal and second anal agree closely, and together differ from the indices of the second dorsal and first anal fins. In the two former fins the rays are set more closely together, which probably means that they are less robust rays than those of the other fins.

The three species agree fairly closely in their respective indices for the first dorsal fin. In all three species the indices for this fin are less than those of the second dorsal and first anal fins.

From the Tables given above it is seen that there is no typical generic number of rays either for the dorsal or anal group. In the two closely related forms, *luscus* and *minutus*, there is an almost identical number of fin-rays for each fin in the dorsal group, but they are both widely separated from *esmarkii* in this comparison. In the matter of the anal fin-rays, *luscus* and *minutus* were separated. Here the anal rays have a specific value. The dorsal fins are together, on the other hand, a sub-generic character. The extent of the dorsal edge of the body furnished with fin-rays is the same in all three species; but the quality of the rays is specific, and involves different numbers.

*The Number of Rays in the Paired Fins and Caudal Fin.*

Species.	Length of the Fish.	Sex.	Vent- ral Fin.	Pecto- ral Fin.	Caudal Fin.
<i>G. luscus.</i>	Cm.				
	24	♂	6	19	...
	26	♂	6	18	38
	27	♂	6	20	40
	27		6	20	...
	Average,		6 (4)	19 (4)	39 (2)
<i>G. minutus.</i>	14	♀	6	19	...
	14	♀	6	19	...
	19	...	6	20	...
	21	♀	6	20	...
	22	♀	6	18	39
	23	♀	6	18	39
	24	♀	6	19	38
	25	...	6	19	...
	Average,		6 (8)	19 (8)	38·6(3)
<i>G. esmarkii.</i>	15	♀	6	20	...
	15	♀	6	19	...
	16	...	6	19	...
	18	♀	6	20	...
	21	♀	6	20	40
	Average,		6 (5)	19·6(5)	...

In all the specimens examined the same number of rays was obtained in the ventral fin, viz., 6. In the case of the pectoral fin there is a fairly similar amount of variation in each species; and the number of caudal rays is apparently very similar in the three species. The absence of variation in the ventral fin is to be expected, from the fact of there being so few rays. That may be one of the factors, but it may also be in part due to the fact that the ventral fin has a well fixed function in the genus—that its function, whatever it may be, is exactly similar in each of the species in which its rays remain the same.

*The Lengths of the Ventral and Pectoral Fins.*

The authors of "The Scandinavian Fishes" state in their description of *G. minutus* that the tip of the ventral fin reaches past the anus. This is not constant. The ventral fin has a long filamentous tip in the three species.

In *luscus* the ventral fin always extends past the anus, but in *minutus* and *esmarkii* the tip of this fin often fails to reach the level of the anus.

Of 18 examples of *minutus*, in 6 the tip of the ventral fin did not reach the anus; in 3 cases it reached the anus exactly; and in 9 cases it passed the anus.

Fifty-two examples of *esmarkii* were examined for this character. In 20 the tip of the ventral fin did not reach the anus; in 20 it reached the anus; and in 12 specimens it reached past the anus.

The tip of the pectoral fin extended past the anus in all the specimens of each species in which the character was noted, viz., 9 examples of *luscus*, 18 of *minutus*, and 43 of *esmarkii*.

#### The Vertebrae.

The details regarding the variation in the number of vertebrae in the three species will be found in Tables I., II., III., IV. They are summarised in Table VI.

The average number of vertebrae was:—*Luscus*, 48·4; *minutus*, 49·4; *esmarkii*, 53·4.

In the matter of the average number of vertebrae, *luscus* and *minutus* come very near each other, the latter exceeding the former by one. *Esmarkii* has the comparatively high average of 53·4. The higher number of vertebrae is accompanied in this species by a higher number of rays in the unpaired fins.

The average number of the vertebra bearing the first hæmal arch was 16 in *luscus*, and the same in *minutus*, while in *esmarkii* the average was 18·6.

#### The Urinary Bladder and Ureter.

The urinary bladder in *luscus* has no lobe; in *minutus* and *esmarkii* it has usually two lobes.

*Luscus*.—None of the specimens examined had a lobe to the urinary bladder. The bladder in this form is coloured a silvery white.

*Minutus*.—In the great majority of cases where this character was noted, two lobes were found attached to the urinary bladder, one on each side. This was the condition in 12 males and 39 females. In 6 specimens (3 males and 3 females) one lobe only was made out. In no case were both lobes absent. They are diverticula of the bladder, and vary in size. Sometimes both are long, narrow processes; one may be a short flap; or both may be small.

In one female 23cm. in length the left lobe had a small secondary lobe attached to it.

In a female 25cm. long, captured in March, both lobes were large; they were well supplied with blood-vessels, and their edges were frilled. Two of the females got at the same time, measuring 23cm., had similar lobes. In another March fish, a male 22cm. long, one lobe only was found, and it was well supplied with blood-vessels. Another male, 22cm., captured in March, had two long lobes which were supplied with blood-vessels, but were not frilled. A ripe female in June had large frilled lobes.

*Esmarkii*.—In this form there are usually two lobes to the urinary bladder. In four cases, however, no lobe was made out. These fish had been for two or three years in the preservative. In 15 specimens one lobe only was distinguished, but in the remaining 63 examples in which the character was noted both lobes were found. The lobes may be both long, or one may be short.

The *Ureter* varies in position with respect to the swim-bladder. It may come down from the kidney on either side of the swim-bladder. Its position has been noted in a number of specimens.

*Luscus*.—Out of 11 cases the ureter was on the left in 7, and on the right in 4.

*Minutus*.—Out of 39 cases the ureter was on the left in 14, and on the right in 25.

*Esmarkii*.—Out of 53 cases the ureter was on the left in 21, and on the right of the swim-bladder in 32.

#### Reproduction.

*G. luscus*.—All the specimens of *luscus* examined were mature. The smallest male in the collection measured 16.8cm., and the next in size was 21cm., while the smallest female was 25cm. long. Fifty-three specimens were examined in all.

The reproductive organs ripen early in the spring.

In January, of the males (24 in number), 22 had large testes, and 2 had developing smaller testes; of 18 females, 17 had large ovaries, and one had a smaller developing ovary.

In February 1 male and 3 females were ripe, and 3 males had large testes. In 1 female there was a developing ovary.

In March 1 female was ripe, and another had a developing ovary.

In May the one specimen examined was a spent female.

A female measuring 24cm. obtained in June had a small ovary.

The ovary is regarded as ripe when it contains transparent eggs. These are to be seen through the skin of the ovary scattered over the ovary, giving the condition known as the "beaded roe." The ovary may thus be labelled ripe before it is actually running. The large ovaries are white "hard roes."

M'Intosh and Masterman give the spawning time of this form as January—February. Fulton found a *luscus* ripe in the Forth in March and another in May. According to Heincke and Ehrenbaum *luscus* spawns at Heligoland from (March?) April to August.

*G. minutus*. All the fishes of this species of which the condition of the reproductive organs has been recorded were mature. The smallest male and female measured 15cm., and above that size mature males were obtained at each centimetre up to the length of 22cm. No male larger than that was found. Mature females were found at every centimetre of length from 15cm. up to 29cm., with the exception of 28cm., at which size no *minutus* was obtained. The evidence therefore points to the conclusion that *minutus* becomes mature both in the male and female at or before reaching a size of 15cm. in length.

The reproductive organs of *minutus* ripen about the same time of the year, but a little later than in *luscus*. Ripe females of *minutus* were not met with till March.

In December 5 females had small developing ovaries.

In January 1 male was ripe, 10 males had large testes, while 1 male had a small developing testis. Thirty females had large ovaries, and 22 had small developing ovaries.

In February 16 males had large testes, 73 females had large ovaries, and 5 females had small developing ovaries.

In March 6 males had nearly ripe testes, 2 females were ripe, and 55 females had large ovaries. In this month nearly all the ovaries were large, white "hard roes."

In May 2 males had nearly ripe testes, and 48 females were ripe.

In June 2 females were ripe and 2 males had fairly large testes. Two males from the Firth of Forth were ripe.

The spawning time of this species is, according to M'Intosh and Masterman, March—June.

The ovary of *luscus* and *minutus* is distinctly triangular. The base of the triangle is parallel and close to the swim-bladder, the apex is the attachment by the oviduct to the anal region. The ovary grows forwards into the abdominal cavity and posteriorly into the post-abdominal cavity.

#### *The Ripe Eggs of Luscus and Minutus.*

*G. luscus*.—The ripe eggs of *luscus* were found in a female in February. The transparent eggs measured  $1.1 \times 1.25$  and  $1.2 \times 1.25$  mm. The opaque eggs in the same ovary measured about .7 mm. in diameter. The fish had been in formaline solution.

In March the eggs, which were dead, were pressed out by the genital aperture. They were ripe, and measured  $1.07 \times 1.25$ ; they were in the fresh condition.

Cunningham found the eggs of a ripe *luscus* to measure from 1.05–1.15 mm. M'Intosh and Masterman found that the ripe eggs of this form after being preserved in spirit measured 1.14–1.16 mm. in diameter.

*G. minutus*.—In January three-fourths of the eggs in the ovary were yolked.

In February, in one fish the yolked eggs measured .55 mm. in diameter.

On April 1 two of the *minutus* were in a spawning condition. The eggs flowed freely out at the genital pore. They were not fertilised: no ripe male was available. After being in water overnight some of the eggs remained transparent and floating. They were measured, and the sizes of their diameters in millimeters were as follows:—1, 1, 1, 1, 1, .97, .97, .97, .97, .97, .97, .95, .9, .9  $\times$  .85, .9  $\times$  .85, .87, .87, .87, .87. Some of the eggs showed a striated zona.

According to M'Intosh the ripe egg of *minutus* measures .906 mm. in diameter.

#### *Maturity of G. esmarkii.*

*G. esmarkii*.—The smallest mature specimens of this form, so far as the development of the reproductive organs bore witness, were a male at 11 cm. and a female measuring 9 cm. in total length. Both had developing genital organs.

Holt found two ripe females, measuring  $4\frac{1}{2}$  in. (about 11 cm.) in length, in April. Fulton says that spawning probably takes place in February and March.

The ovary of *esmarkii* is like that organ in *luscus* and *minutus*—triangular in shape. It has only a slight attachment to the roof of the abdominal cavity, except for the ureter. It grows forward along the floor of the abdominal cavity, and is in some specimens pushed to one side by the great development of the liver.

#### *The Swim-Bladder.*

The swim-bladder in *luscus* and *minutus* is large. It is usually found to be ruptured. In one case an uninjured swim-bladder was noticed.

#### *The Skulls of Luscus, Minutus, and Esmarkii.*

The skulls of *luscus* and *minutus* resemble one another much, and both differ distinctly from the skull of *esmarkii*. The main character of difference is the slope of the ethmoid bone. When the three skulls are

examined in side view the ethmoid in *esmarkii* (E., fig. 9, pl. xi.) is seen to slope backwards quickly, whereas in *minutus* (fig. 6, *ib.*) and *luscus* (fig. 3, *ib.*) it is more nearly vertical.

There are few distinguishing features between the skulls of *luscus* and *minutus*, even when they are compared side by side. To convert these differences into characters by which the skull might be recognised apart from the other is well nigh impossible, so closely are they related.

A general contrast will, therefore, be made between the two.

In two fish of the same size the skull of *minutus* was the larger—it was slightly longer and higher.

*Seen from above*, when the skull is resting on the vomer and the parasphenoid, the calcified base of the ethmoid (E.) is partly hidden by the crest of the bone in *luscus* (fig. 4); in *minutus* the whole of the base is visible (fig. 8).

The processes from the parietals (P. pr.) are large, winglike, in *luscus*; they are narrow in *minutus*. The squamosals (Sq.) project posteriorly farther in *luscus* than in *minutus*. The notch between the frontal (F.) and post-frontal (pt.-F.) which receives the mucous canal passing round the eye, is much smaller in *minutus* than in *luscus*. The frontal in *luscus* contracts a little over the orbits and then expands again into a broadened anterior extremity. In *minutus* it comes to its narrowest over the orbits, and is continued forward with the same breadth.

The breadth of the anterior end of the skull, measured from the outer angle of one pre-frontal (pr.-F.) to the outer angle of the other, is in *luscus* greater than in *minutus*.

*Side view*.—The occipital spine (Oc. Sp.) of *luscus* (fig. 3) is much higher than that of *minutus* (fig. 6). The part of the spine on the frontal rises more rapidly in the former.

The hind edge of the occipital spine may be straight, or it may be slightly incurved just before reaching the occipital foramen.

The front edge of the ethmoid has less backward slope in *luscus* than in *minutus*.

In *minutus* the pre-frontal rises up to meet the outer corner of the frontal: it raises the latter a little. In *luscus* it does not rise so much.

*Seen from below*, the pre-frontal is roughly of a quadrant shape in *luscus* (fig. 12), and of a sextant shape in *minutus* (fig. 11).

The parasphenoid (P.s) is more slender in *minutus* than in *luscus*.

The brain-case is more spherical in shape in *minutus* than in *luscus*.

*Seen from behind*, the squamosal (Sq.) bends outwards and upwards in *luscus* (fig. 5). In *minutus* it projects more in a horizontal direction (fig. 7).

The opisthotic (op. O.) forms in *minutus* a projecting angle where the post-temporal articulates with it; this angle was not noticed in *luscus*.

The par occipital (par.-Oc.) of *luscus* is continued backwards in a projecting angle (*Ang.*), and in consequence the edge of the ex-occipital (e.-Oc., fig. 3) curves downward in a concave sense to the articulation with the shorter arm of the post-temporal. It is thus contrasted strongly with the blunt termination of the par-occipital in *minutus* (fig. 6).

The skull of *esmarkii* is long when compared with that of *minutus*. An *esmarkii* measuring 15.5cm. in length had a skull equal in length to that of a *minutus* 21cm. long.

The ethmoid slopes back very quickly in *esmarkii* (fig. 9). The frontal is narrow over the eyes, and the pre-frontals stand out prominently laterally, but the breadth across them is small (fig. 10).

The vomer projects further in front of the pre-frontals in *esmarkii* (fig. 13) than in *minutus* and *luscus*.



*Otoliths*.—Generally, the otolith of *minutus* was heavier, more massive than that of *luscus*, in fish of the same length. The bossing or marking on the concave surface of the earstone is more distinct in *luscus*; it tends to become smoothed down in *minutus*. Two *minutus* of one length had very different otoliths; in one they were much more massive than in the other fish.

The otolith of *esmarkii* shows a tendency to transverse ridging in place of, or in addition to, bossing on the concave surface.

*The clavicle, &c.*—Slight differences are to be seen in the *clavicle*, *post clavicle*, and *premaxilla* between *minutus* and *luscus*. Thus, in the *clavicle* the ridge dividing the outer surface of the bone is broader and more prominent in *luscus* than in *minutus*. The post clavicle of *minutus* has a curved expanded superior end; in *luscus* the head of the bone is expanded and bent a little off the straight.

In the *premaxilla* the only noticeable difference was in the rather longer and narrower shape of the plate expansion on the distal part of the bone in *minutus*.

#### Teeth.

The teeth are small in *luscus* and *minutus* and minute in *esmarkii*.

#### A Discussion of the Species.

##### *Gadus luscus* and *G. minutus*.

Only a very brief notice of the literature is necessary. Yarrell gives characteristic figures of *luscus* and *minutus*. The specific characters are treated only briefly. He says with regard to *luscus* that it has the power of inflating a membrane which covers its eyes, and for that reason it is called Pout, Bib, Blens, Blinds. The anus is in a line under the origin of the pectoral fin. The end of the rays of the tail are nearly square. It has a dark spot at the origin of the pectoral fin. The Bib is the deepest gadid. The fin-formula given by Yarrell is—1 D, 11; 2 D, 20; 3 D, 16; 1 A, 33; 2 A, 19; P, 18; V, 6. *Vertebræ*, 48.

*G. minutus* has, according to this author, the following fin-formula:—1 D, 12; 2 D, 19; 3 D, 17; 1 A, 25; 2 A, 17; P, 14; V, 6.

At different times the identity of the two species, *G. minutus* and *G. luscus* has been maintained. This is the view which Smitt maintains in the last edition of the "Scandinavian Fishes," although plates showing perfectly characteristic *luscus* and *minutus* are included in the work. According to this author, Steindacher had asserted that the depth of the fish is merely a character of age, and he referred to the same category the character derived from the union of the anals in *luscus* and their separation in *minutus*. The comparative depth of the two species is certainly not a character that can be relied upon. But the deficiency in the second character mentioned I have not been able to find in the adult. Schmidt found this a very reliable character in the very young stages. Further, Smitt remarks that "the size of the eyes has been long since ascertained to undergo a relative diminution with increasing age." The relative size of the eyes in *luscus* and *minutus* is not of much importance.

Smitt has compared 5 *minutus* and 3 *luscus* with respect to a large number of characters. In a considerable proportion of these very close agreement is found between the two species. That is to be expected, since *luscus* and *minutus* resemble one another closely; in fact they form a small group of two fishes very distinct from the other Gadids. The following are the characters which Smitt selected:—Length of the head; distance of the beginning of each of the three dorsal fins from the tip of

the snout; lengths of the ventral and pectoral fins; length of the bases of the third dorsal and first anal fins; the horizontal diameter of the eye; breadth of the hind extremity of the maxilla; distance between the ventral fin and beginning of the first anal fin. All these characters were represented as percentages of the total length of the fish. In most of these characters not only do *luscus* and *minutus* come close together, but they both closely resemble *esmarkii*, as reference to Table XIII. will show. In the characters the length of the bases of the third dorsal, *minutus* and *esmarkii*, come close together, both being separated from *minutus*. In the length of the base of the first anal considerable diversity exists between the three forms. It is not necessary to follow Smitt into the other characters, which are represented as percentages of various standards. It is to be expected that the different species in a genus will show very many points of close resemblance, and that the characters in which they differ may be few. The specific *tout ensemble* may be very characteristic, and still not be easily reduced to a specific description. The specific descriptions of the two fishes in the "Scandinavian Fishes" recite in detail many points in which the two species of *luscus* and *minutus* agree, and do not emphasise the points of difference.

The fin-formulæ and vertebræ given in the "Scandinavian Fishes" are as follows:—

*Luscus*—1 D, 12–14; 2 D, 20–26; 3 D, 18–20; 1 A, 27–35; 2 A, 17–21; Pect., 19–20; Ventr., 6. Vertebræ, 48.

*Minutus*—1 D, 12–15; 2 D, 19–25; 3 D, 17–24; 1 A, 25–31; 2 A, 17–23; Pect., 17–19; Ventr., 6. Vertebræ, 50.

The variations in the number of fin-rays found during the present research are arranged in Table V., p. 149, and the variations in the number of vertebræ appear in Table VI., p. 150.

Schmidt discusses Smitt's evidence on the question of the identity of the two species. He shows that in the young stages *luscus* and *minutus* are quite characteristic, and are easily separated by the specific characters that hold good in the adult. He emphasises the position of the anus with reference to the first dorsal fin, and the union of the anal fins which he finds constant in the young stages. He also lays stress on the difference in depth between the two species. He describes and figures a series of both species up to 5cm. in length.

Parnell, in his account of the Brassy (*Morrhua lusca*), mentions that the scales are very deciduous. It is characterised by a dusky spot at the base of each pectoral, by the first anal fin commencing under the middle of the first dorsal. He had examined *Morrhua lusca* up to a size of 17 inches (42cm.). Parnell says that this fish resembles *Morrhua minuta*, but the latter has a shorter anal fin than *Morrhua lusca*. This author does not record *Morrhua minuta* from the Firth of Forth. The fin-formula of a *Morrhua lusca*, measuring 16 inches (40cm.) in length, he gives as follows:—1 D, 13; 2 D, 24; 3 D, 17; 1 A, 31; 2 A, 18; P, 15; V, 6. In the case of the third dorsal he obtained a number (17) which is less than the smallest number found in any of the specimens examined in the present research, viz., 18 rays.

#### *Gadus esmarkii*.

This form, which was first recorded for Scottish waters by Günther, was obtained by Sir John Murray in the Clyde and certain lochs on the West Coast of Scotland.

The distinctive characters selected by Günther are the following:—

The lower jaw projects beyond the upper.

The teeth of the outer series in the upper jaw are a little larger than the inner ones.

The snout is almost equal to the length of the diameter of the eye. [This character is preferably expressed as follows:—The diameter of the eye is equal to or exceeds the length of the snout.]

The eye is very large, being a little less than one-third of the length of the head.

The barbel is slender, being about half as long as the eye.

The fin-formulæ were—1 D, 15-16; 2 D, 23-25; 3 D, 22-25; 1 A, 27-29; 2 A, 23-25.

In the "Scandinavian Fishes" the fin-formulæ are given as follows:—1 D, 14-16; 2 D, 22-26; 3 D, 22-27; 1 A, 26-30; 2 A, 24-38. Pect., 19. Ventr., 6. Vertebrae, 52.

Attention is called in the latter work to the lateral line which is "dark (though not very distinct) and anteriorly slightly curved."

The numbers of fin-rays and vertebrae found in the *esmarkii* examined for the purpose of this research are set out in Table III., p. 145.

Günther drew attention to the cysts that are found in the eye of *esmarkii*. They are arranged in the iris, may be few in number, or they may occupy almost the whole of the iris, in this way appearing as a ring of white balls. These cysts occur in *minutus* also.

In 1893 Professor M'Intosh described a "peculiar Poor Cod" which is, he informs me, a *Gadus esmarkii*. Professor M'Intosh has kindly permitted me to have a drawing made of this specimen, and it is reproduced in pl. ix.

Since then Dr. Fulton has obtained it in large numbers. Schmidt has described in detail the post-larval and young stages of *G. esmarkii* up to a length of 5.4cm. He remarks that in an example of 19mm. the eyes are but relatively small, their diameter being of the same size or but little larger than the distance from their anterior margin to the end of the snout.

#### A Specific Description.

For the purpose of determining the specific description a large number of measurements was made on specimens of each species. These show that external measurements made on a single fish may be of little value from the point of view of specific diagnosis, since the variation of each character is large, and, so far as is apparent, independent of, or at least not necessarily correlated with, any other contiguous character. The amount of variation which may occur in the characters, while the general specific identity is retained, is large. Specific identity means identity of function. The specific characters mean a difference in the life and habits of the animal which we may not be able at present to estimate. The correlation between the specific characters and the life of the fish is a field hitherto practically unexplored. Thus there are perplexing similarities and differences between fishes. The former mean that the fishes perform similar functions, but at the same time in certain other functions they occupy different spheres in the economy of the sea.

In working out the specific characters it is well to consider the points in which the species agree, in order that these may form part of the generic or sub-generic description. The object of the specific description is to enable an observer to diagnose a single fish, and for that purpose a chart is required.

The Genus may be divided into certain sub-genera. The species may be arranged into two or more groups, each characterised by some common character. The species in each sub-genus may then be distinguished

from one another. Each species might appear in several sub-genera. For example, the members of the cod family discussed in the previous paper and in this, include *G. callarias*, *G. virens*, *G. pollachius*, *G. luscus*, *G. minutus*, and *G. esmarkii*. Now, these may be divided into two groups, as follows:—(a) Group of large fish, *callarias*, *virens*, and *pollachius*; (b) group of small fish. Thus, if the fish is over 17 inches in length it will probably belong to the first group, if less than that it may belong to either group.

Nothing should appear in a specific description except what can be readily gauged without the aid of any accurate measurements. A measurement shown as a percentage of the length is a poor guide except when its fullest range of variation is taken, for its value. The average is of no value by itself, *i.e.*, as a specific character. It may be used to show broad relationships.

Even in the case where two species are so distinct that a glance is sufficient to separate them, still it is often very difficult to get readily gauged characters sufficient to describe the species. The attempt is made to describe a solid by means of a few characters, which are usually mere distances.

#### *The Diagnosis of a Species.*

The simplest mode of diagnosing a species is by means of a key of the genus. Accompanying the key there should be a particular description of the general appearance of each species. The key should be full, so that the species may be determined by different routes. There is hardly a single character which can be absolutely depended on. The specimen which it is desired to diagnose may be affected in such a way as to render a character, even an important one, doubtful. For example, a *G. esmarkii* may be found in which the mouth is fixed wide open, the hyoid and branchiostegal apparatus having become rigid. In such a specimen it could not be determined whether the lower jaw projected in front of the upper or not, and in this way a very valuable character becomes unavailable. In another case a *G. minutus* has been observed in which the lower jaw projected out in line with the upper jaw, if it did not actually pass it slightly. The sum or resultant of the characters has therefore to be relied upon for the sure diagnosis.

#### *General Appearance of the Three Species.*

*Luscus*, fig. 2, pl. viii.; *Minutus*, fig. 1, *ib.*; *Esmarkii*, pl. ix.

They are all three small fishes. The largest size of *luscus* and *minutus* appears to be 17 inches (42cm.), and Fulton gives 10 inches as the length of the largest *esmarkii* recorded so far.

*Luscus* and *minutus* are deep fishes. While *luscus* is the deeper of the two, still considerable variation exists in *minutus* in this character. In one catch of *minutus* obtained in February it was possible to divide the fishes into two groups, in one of which the members were distinctly deeper than those in the other group. The deep group consisted of 15 females measuring from 21cm. to 24cm., while the narrower specimens numbered 42. Of the latter, 7 were males measuring from 17.5cm. to 22cm., and the remainder, 35 females, measured from 20cm. to 25cm. in length. All the fishes had well-developed reproductive organs, and the only difference appeared to be that in the deeper fish the ovaries were rather larger than in the other lot. In a deep fish variations in depth are readily noticed. Where the character is large the variations are comparatively large. *Esmarkii* is a more slender fish than the preceding.

*Colours and Scales.*—The three species have silvery snouts, cheeks, and shoulders.

*Minutus* has large silvery scales that are very easily rubbed off. The exposed part of the scale is covered with dark dots on a ground of silver. The overlapped part of the scale is colourless. The scales of the dorsum above the lateral line have a golden-yellow ground dotted with black. The golden-yellow colour is also seen on the silvery scales on the side.

The scales of *luscus* are smaller than those of *minutus*; they also are very deciduous. On the scale from the side of *luscus* there is a broad edging of black dots. Beneath the scales the skin is thin and somewhat iridescent. When wet the skin of *luscus* has a slight golden sheen, but when dried the black-dotted scales give it a dirty black appearance. In large specimens preserved in formaline the appearance is silvery, but the skin has generally a blackish aspect.

When preserved, *minutus* remains of a brownish-yellow colour, that is when the silvery scales are rubbed off, as usually happens. Where they remain attached the skin becomes of a dark appearance. The skin is of a rougher texture than that of *luscus*. It is slightly pinkish on the dorsum.

In both species the belly is silvery. *Esmarkii* also is silvery on the sides.

*The Axillary Mark.*—In *luscus* the axillary mark is a large blue-black patch covering the sides of the axilla, and extending out on the clavicle and over the base of the pectoral fin. In *minutus* it is a small dark area on the axilla and the base of the first pectoral fin-ray. It does not extend on to the clavicle much. In *esmarkii* there is a very similar axillary mark to *minutus*: it is a collection of small black dots which spread over the base of the pectoral fin.

*The Peritoneum* in *esmarkii* is black, and in preserved specimens the black layer shines through the thin abdominal wall.

*The Fins.*—The anal fins of *luscus* are blue-black; those of *minutus* yellow and black spotted. The first anal of *minutus* is sometimes very dark.

Most of the unpaired fins of *esmarkii* have a black border. Thus the anterior border of the first dorsal is black, while the superior and hind borders of the second and third dorsal fins are likewise black. The black parts of the second anal and caudal fins are the hind border and the hind half of the fin respectively. There are black spots along the bases of the fins, and also on the anterior border of the first anal. The anal fins of preserved specimens are without pigment, except on the anterior part of both fins, where a small area is covered with small dots. This character is more prominent in the larger specimens. The caudal fin is more or less all black.

The second and third dorsals are separate in *minutus* and in *esmarkii*, and are usually separate in *luscus*. In one specimen of *luscus*, however, a male measuring 16·8cm. in length, the second and third dorsals were united.

The first and second anals are separate in *minutus* and *esmarkii*, but are united in *luscus*. There is a thick integument on the unpaired fins in *luscus* and *minutus*. In the former the first anal is a thick flabby fin, the integument being soft and loose. This fin is often inflated with a gas, which can be pressed out at the edge.

There is a characteristic difference between *luscus* and *minutus* in the shape of the third dorsal and second anal fins, as will be seen by reference to Plate VIII. The hind edges of these fins in *luscus* are cut straight across, at right angles to the longitudinal axis of the fish. In *minutus* the hind edges slope away posteriorly. In *esmarkii* the slope is more pronounced and longer than in *minutus* (pl. ix.).

The Caudal Fin of *luscus* has its hind margin slightly concave, that of *minutus* is distinctly concave, and in *esmarkii* the hind margin is deeply cleft.

The ventral fin ends in a filamentous tip in all three species.

The Mandible projects a little in front of the upper jaw in *esmarkii*; in *minutus* and *luscus* the upper jaw projects in front of the lower.

The side and tip of the lower jaw are dark coloured in *esmarkii*. The under-surface of the dentary part of the lower jaw is white in *luscus*; pale, colourless in *minutus*. In consequence, the sensory pits on the under-surface of the dentary show up well in *luscus* and are faint in *minutus*.

The Barbel is long and stout in *luscus* and *minutus*. In *esmarkii* it is thin and short, not being longer than half the diameter of the eye. In the last species the barbel often lies back along the under surface of the lower jaw in the hollow between the two dentaries. The barbel is not so short in *esmarkii* as it is in *Gadus virens*, in which species it is very inconspicuous.

The Lateral Line is curved over the abdomen in all three species. In *luscus* and *esmarkii* the line is dark and more prominent than in *minutus*. The bend rises from the hind straight portion more abruptly in *luscus*; in *minutus* and *esmarkii* the rise is more gradual.

The Anus is beneath the beginning of the first dorsal fin in *luscus*, and beneath the second half of the corresponding fin in *minutus* and *esmarkii*.

The Eye in the three species here discussed is specially large. In *luscus* it is slightly smaller than in *minutus* and *esmarkii*. The diameter of the eye is equal to or greater than the length of the snout, i.e., the distance from the tip of the upper jaw to the anterior edge of the orbit. They all exhibit at times the loose cornea which is sometimes inflated with gas or fluid, giving the eye the well-known bulged appearance. Sometimes cysts are found on the front of the eyeball in the region of the iris.

Two of the larger *esmarkii*, measuring 18.5cm. and 19cm. in length, had eyes which appeared to be larger in proportion than the smaller fishes. The eyes measured in horizontal diameter 7.3 and 7.8 per cent. of the total length of the fish respectively. Four others measuring 19cm., and one of 21cm., had eyes measuring 7 per cent. of the total length of the fish. The small difference in diameter will, of course, entail a considerable difference in the area of the eye, and it is by the area, not the diameter, that the eye of the observer makes the comparison. Any variation towards an increase in the size of an already specially large character will of necessity attract attention.

The barbel in *luscus* is rather bigger and stouter than that of *minutus*. In five specimens of the latter the barbel measured two-thirds or a little more than the horizontal diameter of the orbit.

In the key are introduced the following Gadid species—*G. callarias*, *G. virens*, *G. pollachius*, *G. luscus*, *G. minutus*, and *G. esmarkii*.

#### KEY.

##### I. LOWER JAW (Length of)—

- a. projects in front of Upper Jaw, . . . . . *virens*; *pollachius*; *esmarkii*.
- b. of same length as " " . . . . . *virens* (young); *minutus* (sometimes).
- c. shorter than " " . . . . . *callarias*; *luscus*; *minutus*.

##### II. ANUS (Position of)—

- a. below the beginning of the First Dorsal Fin, . . . . . *luscus*.
- b. " " first half " " " " " " . . . . . *pollachius*; *minutus*.
- c. " " second " " " " " " . . . . . *minutus*; *virens*; *esmarkii*.
- d. " " first half " " Second " " " " . . . . . *callarias*.

- III. LATERAL LINE—  
 a. curved, dark, . . . . . *pollachius*; *minutus*; *luscus*; *esmarkii*.  
 b. „ posterior part white, . . . . . *callarias*.  
 c. straight, white, . . . . . *virens*.
- IV. TAIL FIN (Hind Edge)—  
 a. straight or slightly convex, . . . . . *callarias* (large).  
 b. very slightly concave, . . . . . *callarias* (small); *luscus*.  
 c. slightly concave, . . . . . *minutus*.  
 d. distinctly forked, . . . . . *pollachius*; *esmarkii*.  
 e. deeply cleft, . . . . . *virens*.
- V. SNOUT (The part from tip of upper jaw to anterior edge of the orbit)—  
 a. sharp, . . . . . *virens*; *pollachius*; *esmarkii*.  
 b. blunt, . . . . . *callarias*; *luscus*; *minutus*.
- VI. EYE (horizontal diameter of the orbit)—  
 a. as large as, or larger than, the snout, . . . *luscus*; *minutus*; *esmarkii*.  
 b. not so large as the length of the snout, . . *callarias*; *virens*; *pollachius*.
- VII. BARBEL—  
 a. absent, . . . . . *pollachius*.  
 b. very minute, . . . . . *virens*.  
 c. small, slender, about half the diameter of the eye, . . *esmarkii*.  
 d. big, stout, . . . . . *callarias*; *luscus*; *minutus*.
- VIII. ANAL FINS—  
 a. united, . . . . . *luscus*.  
 b. separate, . . . . . *callarias*; *virens*; *pollachius*; *minutus*; *esmarkii*.
- IX. VENTRAL FIN\* (length of)—  
 a. less than two-thirds of the length of the Pectoral Fin, *virens*; *pollachius*.  
 b. about five-sixths of the length of Pectoral, . . . *callarias*.  
 c. almost as long as the Pectoral, . . . . . *luscus*; *minutus*; *esmarkii*.
- X. SECOND AND THIRD DORSAL FINS—  
 a. united, . . . . . sometimes in *luscus*.  
 b. separate, . . . *callarias*; *virens*; *pollachius*; *luscus*; *minutus*; *esmarkii*.
- XI. GIRTH at Pectoral Region—  
 a. greater than the girth at Anus, . . . . . *callarias*.  
 b. less than the girth at the Anus, . . . *virens*; *pollachius*; *luscus*; *minutus*; *esmarkii*.
- XII. SCALES—very deciduous, . . . . . *luscus*; *minutus*.
- XIII. LENGTH—  
 a. not exceeding 10 inches (25 cm.), . . . *callarias*; *virens*; *pollachius*; *luscus*; *minutus*; *esmarkii*.  
 b. not exceeding 17 inches (42 cm.), . . . *callarias*; *virens*; *pollachius*; *luscus*; *minutus*.  
 c. exceeding 17 inches (42 cm.), . . . *callarias*; *virens*; *pollachius*.

# LITERATURE.

- CUNNINGHAM.—“Marketable Marine Fishes.” London, 1896. [Short descriptions of *G. luscus* and *G. minutus*.]
- DAY.—“The Fishes of Great Britain and Ireland.” London, 1880–1884.
- FULTON.—“The Spawning and Spawning Places of Marine Food-Fishes.” *Eighth Annual Report of the Fishery Board for Scotland*, for the year 1889. [Spawning of *G. luscus*.]
- “On the Comparative Fecundity of Sea-Fishes.” *Ninth Annual Report of the Fishery Board for Scotland*, for the year 1890, p. 243. [Eggs of *G. luscus*.]
- “Ichthyological Notes—*Gadus esmarkii*.” *Nineteenth Annual Report of the Fishery Board for Scotland*, for the year 1902, Pt. III., p. 282. [Distribution of *G. esmarkii*.]

\* The slender tip of the ventral fin may be broken sometimes.

- FULTON.—"Ichthyological Notes—*Gadus esmarkii*." *Twentieth Annual Report of the Fishery Board for Scotland*, for the year 1901, Pt. III., p. 539.
- "The Rate of Growth of Fishes—*Gadus esmarkii*." *Twenty-second Annual Report of the Fishery Board for Scotland*, for the year 1903, p. 195. [Rate of Growth and Distribution.]
- GÜNTHER.—"Catalogue of Fishes in the British Museum."
- "Report on the Fishes obtained by Mr. J. Murray in Deep Water on the North-West Coast of Scotland, between April 1887 and March 1888." *Proceedings Roy. Soc. Edinburgh*, vol. xv., p. 205. 1889. [Specific Description of *Gadus esmarkii*.]
- HEINCKE u. EHRENBaum.—"Eier und Larven von Fischen der deutschen Bucht." II. "Die Bestimmung der Schwimmenden Fischeier und die Methodik der Fimessungen." *Wissen. Untersuch. von der Komm. wissen. Untersuch. der deutschen Meere in Kiel u. Biol. Anstalt auf Helgoland*. N.F. 3er Bd. Abtheil. Helgoland. Hft. 2. 1900. Pp. 131 et seq. [Eggs and Spawning of *G. luscus*.]
- HOLT.—Royal Dublin Society. Report of Council for 1891. [*Gadus esmarkii*.]
- M'INTOSH.—"Report of the St. Andrews Marine Laboratory, No. III." *Fourth Annual Report of the Fishery Board for Scotland*, for the year 1885, p. 201. [*Gadus luscus* and *Gadus minutus*.]
- "Contributions to the Life-Histories and Development of the Food- and other Fishes." *Eleventh Annual Report of the Fishery Board for Scotland*, for the year 1892. Part III. [Eggs of *Gadus minutus*: On a peculiar "Poor Cod" (*G. esmarkii*).]
- M'INTOSH and MASTERMAN.—"The Life-Histories of the British Marine Food-Fishes." London, 1897. [Eggs, larvæ, and post-larval stages of *G. luscus* and *G. minutus*.]
- MÖBIUS u. HEINCKE.—"Die Fische der Ostsee." Berlin, 1883. [Specific Description of *G. minutus*.]
- PARNELL.—"Fishes of the Firth of Forth." Edinburgh, 1838. [Description of *Morrhua lusca*.]
- "SCANDINAVIAN FISHES." (By Fries, Ekström, Sundevall, Wright, and Smitt.) Stockholm, 1893.
- SCHMIDT.—"The Pelagic Post-larval Stages of the Atlantic Species of *Gadus*." 3 Plates and 16 Figures in the Text. Pt. I. *Meddelelser fra Kommissionen for Havundersøgelser*. Serie, Fiskeri. Bind I. No 4. Copenhagen, 1905. [Post-larval stages of *G. luscus*, *G. minutus*, and *G. esmarkii*, with figures.]
- WILLIAMSON.—"On the Pelagic Fish-Eggs and Larvæ of Loch Fyne." *Seventeenth Annual Report of the Fishery Board for Scotland*, for the year 1898. Pt. III., p. 79. [Occurrence of the eggs of *G. luscus* and *G. minutus*.]
- "A Comparison between the Cod (*Gadus callarias*, Linn.), the Saithe (*Gadus virens*, Linn.), and the Lythe (*Gadus pollachius*, Linn.), in respect to certain external and osteological characters." *Twentieth Annual Report of the Fishery Board for Scotland*, for the year 1901. Pt. III., p. 228.
- YARRELL.—"A History of the British Fishes." London, 1861. [Descriptions of *Gadus luscus* and *G. minutus*.]

## EXPLANATION OF PLATES.

## PLATE VIII.

- Fig. 1. *Gadus minutus*, 27 cm. long. ♀, large ovary. *Reduced*.  
 Fig. 2. *Gadus luscus*, 28 cm. ♀, nearly ripe. *Reduced*.

## PLATE IX.

*Gadus esmarkii*. Nat. size.

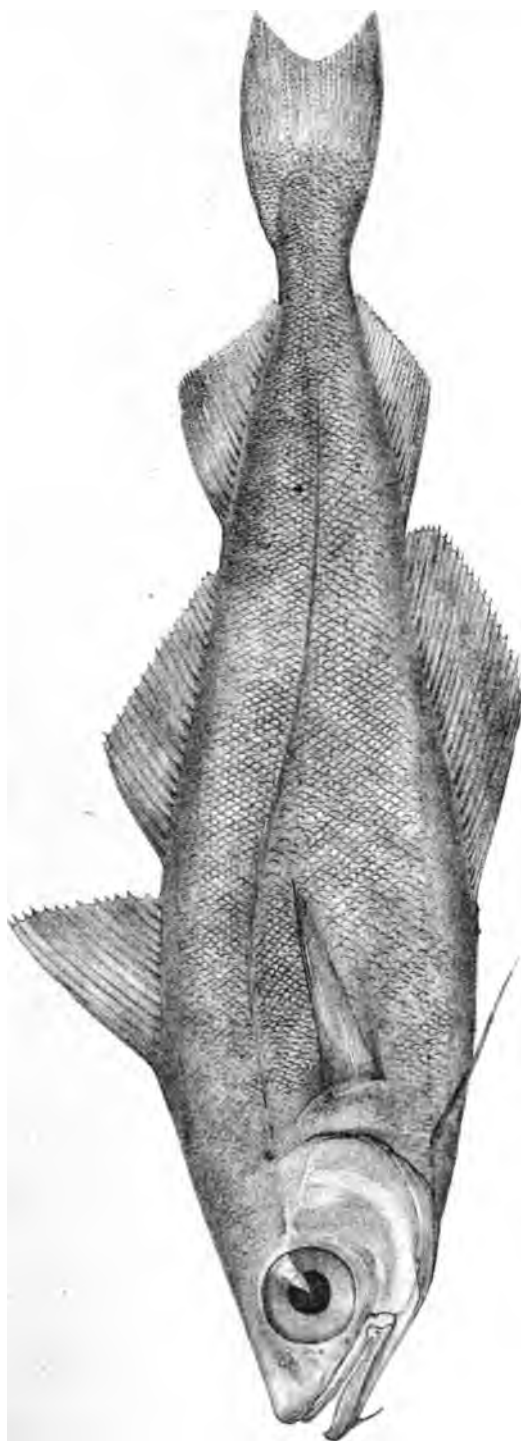
## PLATE X.

- |         |  |         |   |   |   |   |   |   |
|---------|--|---------|---|---|---|---|---|---|
| Fig. 3. | Skull of <i>G. luscus</i> , ♀, 28·7 cm., | .       | . | . | . | . | × | 2 |
| Fig. 4. | " "                                      | " "     | . | . | . | . | × | 2 |
| Fig. 5. | " "                                      | " "     | . | . | . | . | × | 2 |
| Fig. 6. | " <i>G. minutus</i> , 25 cm.,            | .       | . | . | . | . | × | 2 |
| Fig. 7. | " "                                      | 26 cm., | . | . | . | . | × | 2 |
| Fig. 8. | " "                                      | 25 cm., | . | . | . | . | × | 2 |





7



A. H. WALKER.

*Gadus esmarkii.*







Fig. 9.	Skull of <i>G. esmarkii</i> ,	.	.	.	.	.	.	.	x	2
Fig. 10.	"	"	.	.	.	.	.	.	x	2
Fig. 11.	"	<i>G. minutus</i> , 28 cm.,	.	.	.	.	.	.	x	2
Fig. 12.	"	<i>G. luscus</i> , 28 cm.,	.	.	.	.	.	.	x	2
Fig. 13.	"	<i>G. esmarkii</i> ,	.	.	.	.	.	.	x	2
Fig. 14.	"	"	.	.	.	.	.	.	x	2

# LETTERS USED.

*Ang*—Angle.  
*b. Oc.*—Basi-occipital.  
*E.*—Ethmoid.  
*e. Oc.*—Ex-occipital.  
*F.*—Frontal.  
*Oc. Sp.*—Occipital Spine.  
*op. O.*—Opisthotic.  
*P.*—Parietal.

*P. pr.*—Process of Parietal.  
*par. Oc.*—Par-occipital.  
*p. S.*—Parasphenoid.  
*pr. F.*—Pre-frontal.  
*pt. F.*—Post-frontal.  
*Sq.*—Squamosal.  
*V.*—Vomer.

# LIST OF TABLES.

	PAGE.
Localities near Aberdeen where the examples of <i>G. luscus</i> and <i>G. minutus</i> were captured,	118
Localities where some of the <i>G. esmarkii</i> were obtained,	118
Table showing the sex and sizes of the fishes examined,	119
Table showing the average lengths of the bases of the unpaired fins,	124-5
Table showing the ratio of the length of the base of the first anal to that of the second anal,	125
Table giving the sum of the lengths of the bases of the dorsal and anal fins,	126
Table showing the average number of rays in the unpaired fins,	126
Table of the average index of the fin-rays for each fin,	127
Table of the number of rays in the paired fins and caudal fin,	128
TABLE I.— <i>Gadus luscus</i> . Number of VERTEBRÆ, the Number of the Vertebra bearing the First HÆMAL ARCH, and the Number of FIN-RAYS,	142
" II.— <i>Gadus minutus</i> . Number of VERTEBRÆ, the Number of the Vertebra bearing the First HÆMAL ARCH, and the Number of FIN-RAYS,	143-4
" III.— <i>Gadus esmarkii</i> . Number of VERTEBRÆ and FIN-RAYS,	145-7
" IV.— <i>Gadus esmarkii</i> . Number of Vertebra bearing the First HÆMAL ARCH,	148
" V.— <i>Gadus luscus</i> , <i>G. minutus</i> , <i>G. esmarkii</i> . The Range of VARIATION in the Number of FIN-RAYS in each Fin. FREQUENCY of each Number,	149
" VI.— <i>Gadus luscus</i> , <i>G. minutus</i> , <i>G. esmarkii</i> . The Range of VARIATION in the Number of VERTEBRÆ. Frequency of each Number,	150
" VII. and VIII.— <i>Gadus luscus</i> . The BODY-DIMENSIONS represented as Percentages of the Length of the Fish. AVERAGE at each size (Centimetre groups),	151-2
" IX. and X.— <i>Gadus minutus</i> . The BODY-DIMENSIONS represented as Percentages of the Length of the Fish. AVERAGE at each size (Centimetre groups),	153-4
" XI. and XII.— <i>Gadus esmarkii</i> . The BODY-DIMENSIONS represented as Percentages of the Length of the Fish. AVERAGE at each size (Centimetre groups),	155-6
" XIII.— <i>Gadus luscus</i> , <i>G. minutus</i> , <i>G. esmarkii</i> . The Range of VARIATION of the BODY-DIMENSIONS,	157

TABLE I.—*Gadus Luscus*.

*Number of Vertebrae, Number of Vertebra bearing the First Hæmal Arch, and Number of Fin-rays.*

Length. Cm.	Sex.	VERTEBRÆ.		FIN-RAYS.				
		Total Number.	Vertebra bearing first Hæmal Arch.	1 D.	2 D.	3 D.	1 A.	2 A.
16.8	♂	49	16	14	26	22	35	22
21.5	♂	48	16	18	24	20	35	22
24.5	♂	48	16	12	22	20	31	20
25	♂	48	16	15	22	19	32	21
26.2	♂	49	17	15	22	19	33	21
26.4	♂	48	16	13	23	19	32	21
26.6	♂	49	16	14	24	20	36	22
27.4	♂	48	16	14	24	19	34	22
27.8	*	49	16	13	21	18	32	18
28.7	♀	48	16	13	22	21	34	22
30.4	♀	49	16	13	23	18	33	21
32.7	♀	49	16	13	24	21	35	21
40	♀	48	16	14	25	19	36	22
Average, -		48.4	16	13.5	23.3	19.6	33.7	21
Variants, -		13	13	13	13	13	13	13

\* Sex not recorded.



TABLE II.—*Gadus Minutus*.

Number of Vertebrae, Number of Vertebra bearing the First Hæmal Arch and Number of Fin-rays.

Length. Cm.	Sex.	VERTEBRÆ.		FIN-RAYS.				
		Total Number.	Vertebra bearing first Hæmal Arch.	1 D.	2 D.	3 D.	1 A.	2 A.
11	♀	49	...	13	24	20	27	20
11.3	♀	50	...	13	23	21	28	23
11.4	♀	50	...	13	24	23	28	23
14	♀	49	...	13	23	...	29	21
14.6	♀	50	...	14	22	21	26	22
16.6	♀	49	...	12	24	22	27	21
17.2	♀	49	16	11	23	23	27	22
17.3	♂	49	16	13	22	20	...	21
17.8	♂	49	16	13	26	21	30	23
18	♀	50	17	...	...	...	...	...
18.2	♂	48	16	...	...	...	...	...
18.2	♂	50	16	...	...	...	...	...
18.6	♀	49	17	14	24	23	29	22
19.4	♂	50	16	13	23	21	29	23
19.6	♀	49	16	12	24	20	28	22
19.7	...	...	...	12	22	21	28	22
20	♀	48	16	...	...	...	...	...
20	♀	...	...	13	23	21	28	21
20.5	♀	48	16	13	20	22	29	22
21	♂	51	16	12	24	21	28	21
21	♂	50	17	14	...	21	28	23
21	♀	49	16	...	...	...	...	...
21.2	♀	49	16	12	22	21	28	22
21.3	♀	49	16	12	22	21	29	22
21.4	♂	51	16	14	21	22	...	22
21.5	♂	49	15	13	23	19	28	21
21.6	♀	50	16	...	...	...	...	...
21.7	♀	50	16	...	...	...	...	...
21.7	♂	50	...	13	20	21	27	23
21.8	♀	49	16	12	24	23	29	23
21.8	♀	49	16	13	22	22	27	23

TABLE II.—continued.

Length. Cm.	Sex.	VERTEBRÆ.		FIN-RAYS.				
		Total Number.	Vertebra bearing first Hæmal Arch.	1 D.	2 D.	3 D.	1 A.	2 A.
22	♀	...	...	12	22	...	...	...
22	♀	50	16	12	26	22	29	24
22	♀	48	16	...	...	...	...	...
22	♀	51	17	...	...	...	...	...
22	♀	49	16	13	23	23	29	22
22.2	♀	50	16	...	31	21	27	22
22.2	♀	50	16	...	...	...	...	...
22.4	♂	50	17	12	25	21	28	22
22.4	♀	50	16	...	...	...	...	...
22.5	♀	49	15	...	...	...	...	...
22.6	♀	49	16	12	24	23	...	24
23	♀	48	15	12	22	22	27	23
23	♀	49	16	14	21	22	...	23
23	♀	50	...	...	...	...	...	...
23	♀	50	16	12	21	21	29	22
23.3	♀	50	16	15	23	21	29	23
23.3	♀	49	15	...	...	...	...	...
24	♀	49	16	13	23	22	29	21
24.2	♀	49	16	...	...	...	...	...
24.4	♀	49	16	13	21	23	27	22
24.8	♀	50	18	13	24	20	28	21
25.3	♀	50	...	13	24	22	31	24
25.4	...	49	16	12	26	20	29	23
26.4	♀	49	17	13	24	21	30	23
Average, -		49.4	16	12.7	22.9	21.4	28.2	22.2
Variants, -		52	43	39	39	38	35	39

TABLE III.—*Gadus Esmarkii*.  
Number of Vertebrae and Fin-rays.

Length. Cm.	Sex.	VERTEBRÆ. Total Number.	FIN-RAYS.				
			1 D.	2 D.	3 D.	1 A.	2 A.
8.6	♀	...	15	24	24	29	26
9.5	...	...	16	24	26	29	27
10	♀	...	16	24	28	29	29
10	...	...	15	26	24	29	27
10.6	♂	53	14	25	26	27	28
10.6	...	...	15	24	26	30	26
10.8	...	...	15	27	27	29	27
11	♂	...	15	25	27	29	28
11.3	...	...	15	25	25	27	29
11.3	...	...	15	26	26	30	29
11.3	...	...	15	...	26	29	27
11.5	...	...	16	25	26	27	28
11.8	♂	...	15	25	27	29	29
11.8	♂	...	15	25	25	30	27
11.8	♀	...	16	26	28	30	26
11.8	...	...	14	23	24	27	28
12	♂	...	15	23	23	27	26
12	♂	...	16	27	26	30	26
12	♀	...	16	28	27	31	27
12	...	...	14	26	26	30	27
12	♂	...	16	22	25	28	28
12	♀	...	15	22	26	27	24
12.2	♀	...	14	25	26	29	26
12.2	...	...	16	26	26	32	28
12.4	♀	...	16	26	27	28	27
12.8	♀	...	16	22	24	26	28
12.8	♀	54	17	24	25	31	28
13	♂	54	15	28	25	31	28
13.5	♂	53	15	26	25	30	26
13.6	♀	...	15	26	25	30	...
13.8	♀	53	15	24	25	28	27
14	♀	53	15	22	26	25	28
14.2	♀	54	16	27	27	32	28

TABLE III.—continued.

Length. Cm.	Sex.	VERTEBRÆ. Total Number.	FIN-RAYS.				
			1 D.	2 D.	3 D.	1 A.	2 A.
14.3	♂	54	15	25	26	30	27
14.3	♀	55	16	23	26	30	26
14.4	♀	54	15	27	27	30	28
14.5	♀	...	15	26	27	30	29
14.5	...	...	14	27	27	29	29
14.6	♂	...	15	26	...	29	...
14.6	♂	...	16	24	26	28	26
14.6	♀	...	15	27	26	30	26
14.7	♀	53	16	25	25	29	28
14.7	♀	...	15	25	24	29	27
14.7	♀	53	17	26	29	30	28
14.7	♀	53	15	24	26	27	29
14.7	...	54	15	24	26	29	27
14.8	♂	...	15	25	26	28	27
14.8	♀	54	14	27	25	30	25
14.8	♀	52	16	...	28	29	28
14.8	♀	54	15	28	27	29	28
15	♂	...	16	24	27	30	27
15	♀	...	16	24	25	26	26
15.2	♂	53	16	24	28	30	28
15.2	♀	...	16	26	26	30	27
15.2	♀	55	16	26	26	30	27
15.3	♀	54	15	29	26	29	27
15.4	♀	54	...	...	...	...	...
15.4	♀	...	15	26	28	30	29
15.4	♀	53	14	28	25	28	27
15.5	♂	...	16	25	26	29	28
15.5	♀	52	15	27	27	31	27
15.5	♀	53	...	...	...	...	...
15.5	♀	54	15	25	27	30	28
15.5	♀	52	14	27	24	32	...
15.5	♀	54	18	26	26	27	29
15.5	♀	...	16	27	28	31	29
15.5	♀	54	14	28	25	31	27

TABLE III.—continued.

Length. Cm.	Sex.	VRRTEBRÆ. Total Number.	FIN-RAYS.				
			1 D.	2 D.	3 D.	1 A.	2 A.
15·6	♀	53	16	26	27	30	28
15·6	♀	53	15	27	26	30	27
15·6	♀	53	16	25	27	29	27
15·6	♀	53	15	24	28	28	27
15·7	♂	53	14	21	23	27	26
15·7	♀	...	16	26	26	29	27
15·7	♀	...	15	25	...	30	26
16	♀	53	15	25	25	29	25
16	♀	54	15	24	26	28	25
16	♀	...	15	...	26	28	27
16	...	53	15	27	26	31	26
16·3	♀	54	16	25	25	27	26
16·3	♀	53	17	24	25	28	26
16·5	♀	54	16	24	26	27	29
16·6	♀	...	15	26	28	30	28
16·6	♀	53	16	25	26	28	26
16·7	♀	...	...	25	27	29	26
16·8	♀	53	15	25	26	27	26
17	♀	53	15	26	25	30	26
17	♀	54	15	25	27	27	26
17	♀	..	15	24	28	28	28
17·2	♂	54	14	24	26	30	27
17·3	♀	53	16	24	28	28	27
17·5	♀	53	15	23	...	28	30
17·6	♀	...	15	27	25	29	27
17·8	♀	54	15	24	26	28	24
18·4	♀	...	...	...	28	24	28
18·6	♀	52	15	25	...	...	...
21	♀	54	16	25	28	30	30
...	♀	54	15	26	28	29	28
Average,		53·4	15·3	25	26	(28·9) 29	27·2
Variations,		50	93	92	91	94	91

TABLE IV.—*Gadus Esmarkii*.*Number of the Vertebrae bearing the first Hæmal Arch.*

Length. Cm.	Sex.	Total Number of VERTEBRÆ.	Number of the Vertebra bear- ing the first Hæmal Arch.
14·7	♀	53	18
14·7	...	54	19
15·2	♂	53	18
15·5	♀	52	19
17·2	♂	54	18
17·5	♀	53	19
21	♀	54	19

TABLE V.--The Range of Variation in the Number of Fin-rays in each Fin.  
Frequency of each Number.

SPECIES.	FIN.	NUMBER OF FIN-RAYS.																				NUMBER OF VARIANTS.						
		11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		31	32	33	34	35	36
GADUS LUSCUS.	First Dorsal, -	...	1	6	4	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13
	Second Dorsal, -	...	...	...	...	...	...	...	...	...	1	4	2	4	1	1	...	...	...	...	...	...	...	...	...	...	13	
	Third Dorsal, -	...	...	...	...	...	...	...	2	5	3	2	1	...	...	...	...	...	...	...	...	...	...	...	...	...	13	
	First Anal, -	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	3	2	2	3	2	13
	Second Anal, -	...	...	...	...	...	...	...	1	...	1	5	6	...	...	...	...	...	...	...	...	...	...	...	...	...	13	
GADUS MINUTUS.	First Dorsal -	1	14	18	5	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	39	
	Second Dorsal, -	...	...	...	...	...	...	...	...	2	5	8	9	11	1	3	...	...	...	...	...	...	...	...	...	...	39	
	Third Dorsal, -	...	...	...	...	...	...	...	...	1	5	16	9	7	...	...	...	...	...	...	...	...	...	...	...	...	38	
	First Anal, -	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	8	11	12	2	1	...	...	...	...	...	35	
	Second Anal, -	...	...	...	...	...	...	...	...	1	8	14	13	3	...	...	...	...	...	...	...	...	...	...	...	...	39	
GADUS ESMARKII.	First Dorsal, -	...	...	...	11	48	30	3	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	93	
	Second Dorsal, -	...	...	...	...	...	...	...	...	...	1	4	4	20	23	20	13	6	1	...	...	...	...	...	...	...	92	
	Third Dorsal, -	...	...	...	...	...	...	...	...	...	...	...	2	6	18	34	17	13	1	...	...	...	...	...	...	...	91	
	First Anal -	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	2	13	15	24	23	7	3	...	...	...	94	
	Second Anal, -	...	...	...	...	...	...	...	...	...	...	...	...	...	2	3	21	28	24	11	2	...	...	...	...	...	91	

TABLE VI.

*Variations in the Number of Vertebrae—Frequency of each Number.*

Species.	Number of Vertebrae.								Number of Variants	Average Number of Vertebrae.
	48	49	50	51	52	53	54	55		
<i>Gadus luscus,</i> .	7	16	...	...	...	...	...	...	13	48·4
<i>Gadus minutus,</i>	5	24	20	3	...	...	...	...	52	49·4
<i>Gadus esmarki,</i>	...	...	...	...	4	23	21	2	50	53·4



Length. Cm.	Variants.			Girth.			Dorso-Ventral Height of Body.		Eye. Horiz. Diam.	Inter- orbital Space.	Greatest Length of Fins.			Height of Lat. Line above Lat. Axis.		Rami of Tail.			Greatest Height— Unpaired Fins.				
	♂	♀	Total	Axil- lary.	At Anus.	Tail.	Pec- toral.	At Anus.			Ventr.	Pect.	1 D.	At Anus.	At P.-fin.	l. Dorsal.	l. Ventr.	Spred.	1 D.	2 D.	3 D.	1 A.	2 A.
16.8	1	...	1	56 (1)	63 (1)	15 (1)	24 (1)	24 (1)	6 (1)	6 (1)	14 (1)	18 (1)	20 (1)	9 (1)	...	...	...	...	...	...	...	...	...
21	1	...	1	55 (1)	55 (1)	13 (1)	20 (1)	22 (1)	6 (1)	6 (1)	15 (1)	16 (1)	19 (1)	7 (1)	6 (1)	...	...	...	...	...	...	...	...
24	2	...	2	...	...	...	...	...	6 (2)	5 (2)	15 (1)	17 (1)	19 (1)	7 (1)	6 (1)	18 (1)	18 (1)	8 (1)	...	...	...	...	...
25	3	1	4	60 (1)	63 (1)	14 (1)	25 (1)	26 (1)	6 (2)	6 (2)	15 (1)	17 (1)	...	8 (1)	...	...	...	...	...	...	...	...	...
26	6	2	8	53 (1)	59 (2)	14 (2)	23 (1)	25 (2)	6 (8)	6 (8)	15 (2)	18 (2)	22 (2)	6 (1)	7 (1)	20 (1)	20 (1)	9 (1)	14 (1)	9 (1)	6 (1)	10 (1)	8 (1)
27	7	5	13*	60 (2)	64 (2)	15 (2)	24 (2)	27 (2)	6 (11)	6 (11)	14 (2)	17 (2)	18 (2)	7 (2)	6 (2)	17 (1)	18 (1)	10 (1)	13 (1)	8 (1)	8 (1)	9 (1)	8 (1)
28	1	6	8*	64 (1)	69 (1)	14 (1)	26 (1)	28 (1)	6 (6)	5 (6)	17 (1)	17 (1)	...	7 (1)	...	...	...	...	...	...	...	...	...
29	1	2	3	...	...	...	...	...	6 (8)	6 (8)	...	...	...	...	...	...	...	...	...	...	...	...	...
30	3	2	5	...	...	...	...	...	6 (5)	6 (5)	...	...	21 (1)	...	...	...	...	...	...	...	...	...	...
31	...	2	2	...	...	...	...	...	6 (2)	5 (2)	...	...	...	...	...	...	...	...	...	...	...	...	...
32	...	2	2	...	...	...	...	...	6 (2)	6 (2)	...	...	21 (1)	...	...	...	...	...	...	...	...	...	...
33	2	...	2	...	...	...	...	...	6 (2)	5 (2)	...	...	...	...	...	...	...	...	...	...	...	...	...
34	2	...	2	...	...	...	...	...	6 (2)	5 (2)	...	...	...	...	...	...	...	...	...	...	...	...	...
35	1	2	3	...	...	...	...	...	6 (3)	6 (3)	...	...	...	...	...	...	...	...	...	...	...	...	...
40	...	1	1	63 (1)	66 (1)	14 (1)	26 (1)	27 (1)	6 (1)	5 (1)	16 (1)	18 (1)	...	6 (1)	6 (1)	...	...	...	14 (1)	10 (1)	8 (1)	9 (1)	9 (1)
Average.	...	...	...	60	63	14	24	26	6	6	15	17	20	7	6	18	19	9	14	9	7	9	8
Variant.	...	...	...	8	9	9	8	9	51	51	10	10	9	10	6	3	3	3	3	3	3	3	3

\* The total includes one fish of undetermined sex.



TABLE IX.—*Gadus minutus*. The Body-Dimensions represented as Percentages of the Length of the Fish. Average of each Size (Centimetre Groups).

Length. Cm.	Variants.		Birth.		Dorso-Ventral Height of Body.		Eye. Horiz. Diam.	Inter- orbital Space.	Greatest Length of Fins.		Height of Lateral Line above Lat. Axis.	Rami of Tail.		Greatest Height-- Unpaired Fin.				Length of Barbel.		
	♂	♀	Total.		Pec. total.	At Tail.			Pec. total.	At Anus.		Ventr.	Pect.	1 D.	At Anus.	At P.-fin.	1 D.		2 D.	3 D.
11	...	1	1	...	...	...	8 (1)	5 (1)	...	...	...	...	...	...	...	...	...	...	...	
14	...	2	2	46 (1)	48 (1)	11 (1)	18 (1)	4 (1)	...	12 (2)	16 (2)	18 (1)	6 (1)	6 (1)	...	13 (1)	5 (1)	...	5 (1)	
16	2	1	3	48 (1)	47 (1)	11 (1)	18 (1)	4 (1)	...	14 (1)	15 (1)	16 (1)	5 (1)	5 (1)	17 (1)	9 (1)	5 (1)	4 (1)	5 (1)	
17	3	2	5	49 (2)	52 (2)	13 (2)	20 (2)	5 (2)	...	...	...	...	...	...	...	...	...	...	...	
18	2	2	4	51 (4)	52 (4)	13 (4)	20 (4)	4 (4)	...	...	...	...	...	...	...	...	...	...	...	
19	2	4	7*	50 (4)	54 (4)	13 (3)	21 (3)	5 (3)	...	17 (1)	18 (1)	...	...	...	...	...	...	...	...	
20	1	2	3	49 (1)	52 (1)	13 (1)	...	...	...	...	...	...	...	...	...	...	...	...	...	
21	5	9	15*	51 (7)	54 (7)	13 (7)	20 (5)	5 (5)	...	14 (4)	16 (4)	18 (5)	6 (4)	5 (4)	18 (1)	18 (1)	...	...	...	
22	1	12	13	53 (5)	55 (5)	15 (5)	20 (5)	5 (5)	...	14 (5)	16 (5)	19 (2)	6 (4)	5 (4)	18 (1)	18 (1)	...	...	...	
23	...	6	6	52 (3)	55 (3)	13 (3)	19 (2)	5 (2)	...	13 (2)	16 (2)	19 (1)	5 (2)	5 (2)	...	...	...	...	...	
24	...	6	7*	51 (3)	55 (3)	13 (3)	18 (2)	4 (2)	...	14 (2)	16 (2)	19 (1)	5 (3)	5 (3)	...	...	...	...	...	
25	...	4	5*	50 (2)	52 (2)	13 (2)	20 (2)	5 (1)	...	13 (2)	16 (2)	17 (1)	6 (2)	6 (2)	...	...	...	...	...	
26	...	2	2	53 (1)	55 (1)	13 (1)	19 (1)	5 (1)	...	16 (1)	16 (1)	...	5 (1)	5 (1)	...	...	...	...	...	
Average, -		-	-	53	53	13	20	21	5	14	16	18	6	5	18	18	5	5	5	
Variants, -		-	-	34	34	33	28	27	60	57	19	20	3	18	18	3	3	2	2	1

\* The total includes a fish of undetermined sex.

\* The total includes a fish of undetermined sex.

TABLE X.—*Gadus Minutus*. The Body-Dimensions represented as Average Percentages in the Length of the Fish.

Length. Cm.	Variants.			Distance from Tip of PREMAXILLA.																Lateral Line— End of Bend.				
	♂	♀	Total.	Eye.	Ventr. Fin.	Operculum.		Pect. Fin.	Anus.	1 D.		2 D.		3 D.		1 A.		2 A.			Base of Tail.		Rami of Tail.	
						Cleft.	Hind Edge.			Begin- ning.	End.	Begin- ning.	End.	Begin- ning.	End.	Begin- ning.	End.	Dorsal.	Ventr.		d. Tip.	v. Tip.		
14	...	2	2	5 (1)	18 (1)	18 (1)	...	24 (1)	33 (1)	26 (1)	37 (1)	38 (1)	61 (1)	63 (1)	79 (1)	35 (1)	62 (1)	65 (1)	81 (1)	83 (1)	...	101 (1)	..	50 (1)
16	2	1	3	4 (1)	23 (1)	20 (1)	...	24 (1)	32 (3)	26 (1)	37 (1)	38 (1)	63 (1)	65 (1)	80 (1)	35 (1)	63 (1)	64 (1)	81 (1)	84 (1)	84 (1)	101 (1)	101 (1)	50 (1)
17	3	2	5	4 (2)	19 (3)	20 (3)	21 (3)	22 (3)	32 (3)	24 (3)	36 (3)	37 (3)	62 (3)	64 (3)	79 (3)	33 (3)	62 (2)	65 (3)	81 (3)	...	...	102 (1)	102 (3)	...
18	2	2	4	4 (4)	19 (4)	19 (4)	20 (4)	22 (4)	31 (4)	25 (4)	35 (4)	38 (4)	62 (4)	64 (4)	80 (4)	33 (4)	63 (4)	64 (4)	81 (4)	...	...	101 (2)	101 (3)	...
19	2	4	7*	5 (4)	19 (3)	21 (3)	22 (3)	23 (3)	32 (7)	26 (3)	37 (3)	38 (3)	63 (3)	65 (3)	80 (3)	35 (3)	64 (3)	66 (3)	81 (3)	...	...	101 (2)	102 (3)	...
20	1	2	3	5 (1)	19 (1)	20 (1)	21 (1)	22 (1)	33 (2)	26 (1)	37 (1)	39 (1)	62 (1)	63 (1)	79 (1)	34 (1)	63 (1)	65 (1)	80 (1)	...	...	...	101 (1)	...
21	5	9	15*	5 (13)	19 (11)	20 (11)	21 (10)	22 (11)	32 (15)	25 (7)	37 (7)	38 (7)	63 (7)	64 (7)	80 (7)	34 (7)	63 (7)	66 (7)	81 (7)	83 (4)	84 (4)	101 (4)	102 (6)	55 (4)
22	1	12	13	4 (10)	19 (6)	20 (6)	21 (6)	22 (6)	32 (13)	25 (5)	36 (5)	38 (5)	63 (5)	65 (5)	80 (5)	35 (5)	64 (7)	65 (5)	81 (7)	83 (5)	84 (5)	102 (5)	101 (5)	55 (4)
23	...	6	6	5 (4)	18 (3)	20 (3)	22 (3)	22 (6)	32 (6)	25 (3)	36 (3)	39 (3)	62 (3)	64 (3)	79 (3)	35 (3)	64 (5)	65 (3)	81 (5)	84 (3)	83 (3)	101 (3)	101 (3)	51 (3)
24	...	6	7*	5 (3)	18 (3)	20 (3)	22 (3)	22 (3)	33 (7)	26 (3)	37 (3)	38 (3)	...	65 (3)	80 (3)	36 (3)	65 (5)	66 (3)	82 (5)	83 (3)	84 (3)	102 (3)	101 (2)	55 (3)
25	...	4	5*	5 (2)	19 (2)	19 (2)	22 (1)	23 (2)	32 (4)	26 (2)	36 (2)	37 (2)	63 (1)	64 (2)	80 (2)	33 (2)	64 (5)	65 (2)	82 (5)	84 (2)	84 (2)	101 (2)	101 (2)	55 (2)
26	...	2	2	6 (1)	19 (1)	21 (1)	22 (1)	23 (1)	32 (2)	27 (1)	38 (1)	40 (1)	65 (1)	67 (1)	82 (1)	35 (1)	67 (1)	68 (1)	82 (1)	85 (1)	85 (1)	103 (1)	102 (1)	54 (1)
27	...	1	1	...	...	...	...	...	33 (1)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Average, -	-	-	-	5	19	20	21	22	32	25	36	36	63	64	80	34	64	65	81	83	84	101	101	34
Variants, -	-	-	-	46	39	39	35	39	68	34	34	34	30	34	34	34	42	34	43	20	19	25	30	19

\* The total includes a fish of undetermined sex.

TABLE XI.—*Gadus Esmarkii*. The Body-Dimensions represented as Percentages of the Length of the Fish. Average at Each Size (Centimetre Groups).

Length. Cm.	Variants.			Girth.			Dorso-Ventral Height of Body.			Eye. Horiz. Diam.	Inter- or- Space.	Greatest Length of Fins.			Height of Lateral Line above Lat. Axis.			Rami of Tail.			Greatest Height of Unpaired Fins.					Length of Barbel.	Inter-ocular Diameter.		Caudal Peduncle.	Greatest Girth.			
	♂	♀	Total	Pec- toral.	At Anus.	Tail.	Pe c oral.	At Anus.	Tail.			Ventr	Pect.	At Anus.	P. fin.	At Dorsal.	L. Ventr.	L. Spread	1 D.	2 D.	3 D.	1 A.	2 A.	Fore.	Hind.								
8.6	..	1	1	..	..	..	..	..	8 (1)	6 (1)	12 (1)	..	..	..	..	..	..	..	..	..	..	..	..	2 (1)	..	..	..	..					
9	..	1	9*	..	..	..	..	..	7 (1)	5 (1)	10 (1)	..	..	..	..	..	..	..	..	..	..	..	..	2 (1)	..	..	..	..					
10	1	1	4*	..	..	..	..	..	8 (3)	5 (3)	13 (3)	..	..	..	..	..	..	..	..	..	..	..	..	3 (3)	..	..	..	..					
11	2	5	8*	..	..	..	..	..	7 (8)	5 (8)	14 (1)	..	..	..	..	..	..	..	..	..	..	..	..	3 (1)	..	..	..	..					
12	..	4	4	37 (1)	36 (1)	9 (1)	..	..	7 (4)	6 (3)	14 (1)	17 (1)	..	..	..	..	..	..	..	..	..	..	..	3 (1)	..	..	..	..					
13	2	2	4	44 (3)	42 (3)	11 (3)	..	..	7 (3)	5 (2)	15 (3)	17 (3)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
14	3	10	14*	45 (11)	46 (11)	11 (11)	18 (2)	18 (2)	7 (14)	5 (13)	14 (11)	17 (11)	..	..	..	..	..	..	..	..	..	..	..	2 (11)	8 (3)	9 (3)	4 (11)	..	..	..	..	..	
15	4	17	21	45 (16)	47 (16)	11 (16)	18 (4)	19 (4)	7 (21)	5 (21)	14 (18)	17 (19)	..	..	..	..	12 (1)	10 (1)	8 (1)	5 (1)	..	..	..	3 (13)	8 (3)	10 (3)	4 (10)	48 (1)	..	..	..	..	
16	..	11	12*	46 (8)	47 (9)	11 (9)	17 (1)	17 (1)	7 (12)	5 (12)	13 (10)	17 (10)	6 (1)	6 (1)	17 (1)	17 (1)	8 (1)	7 (1)	5 (1)	5 (1)	4 (1)	..	..	3 (4)	8 (1)	9 (1)	4 (9)	..	..	..	..	..	
17	1	8	9	46 (7)	47 (6)	11 (7)	..	..	7 (9)	5 (9)	13 (8)	17 (8)	4 (2)	4 (2)	3 (2)	..	..	..	..	..	..	..	..	3 (5)	7 (1)	10 (1)	4 (8)	..	..	..	..	..	
18	..	5	5	45 (1)	46 (1)	10 (1)	..	..	7 (4)	5 (4)	14 (1)	16 (1)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
19	..	3	3	..	..	..	..	..	7 (3)	5 (2)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
21	..	1	1	45 (1)	48 (1)	11 (1)	18 (1)	19 (1)	7 (1)	5 (1)	15 (1)	17 (1)	4 (1)	4 (1)	5 (1)	18 (1)	17 (1)	8 (1)	6 (1)	5 (1)	5 (1)	4 (1)	..	..	..	..	..	..	..	..	..	..	
Average, . . .	..	..	..	45	46	11	18	18	4	7	5	14	17	4	4	4	17	17	9	8	6	5	5	4	3	7	9	4	48	..	..	..	
Variants, . . .	..	..	..	43	48	49	8	8	8	84	80	59	54	4	4	4	2	2	3	3	3	2	2	..	41	10	10	41	1	..	..	..	..

\* The total includes a fish of undetermined sex.

TABLE XII.—*Gadus esmarkii*. The Body-Dimensions represented as Percentages of the Length of the Fish. Average at each Size (Centimetre Groups).

Length. Cm.	Variants.			Distance from Anterior Point of Fish, viz. :—Tip of MANDIBLE.																		
	♂	♀	Total.	Eye.	Ventr. Fin.	Operculum.		Pect. Fin.	Anus.	1 D.		2 D.		3 D.		1 A.		2 A.		Rami of Tail— Dorsal Tip.	Lateral Line— End of Bend.	Tip of Premax- illa.
						Cleft.	Hind Edge.			Begin- ning.	End.	Begin- ning.	End.	Begin- ning.	End.	Begin- ning.	End.					
8.6	..	1	1	..	..	..	..	..	38 (1)	28 (1)	38 (1)	..	..	..	..	..	..	..	..	..	..	1 (1)
9	..	1	2*	..	..	23 (1)	..	..	34 (2)	36 (2)	39 (2)	..	..	..	..	..	..	..	..	..	..	1 (1)
10	1	1	4*	..	..	..	..	..	34 (4)	25 (2)	38 (2)	..	..	..	..	61 (1)	..	..	..	103 (2)	..	1 (9)
11	5	5	11*	..	..	..	..	..	34 (11)	26 (1)	38 (1)	..	..	..	..	62 (3)	..	..	..	..	..	9 (1)
12	3	8	11	5 (1)	..	..	..	..	34 (11)	27 (1)	37 (1)	..	..	..	..	61 (8)	..	..	..	103 (1)	..	..
13	2	3	5	6 (2)	21 (1)	19 (2)	21 (1)	22 (1)	34 (2)	26 (2)	38 (2)	37 (1)	60 (1)	64 (1)	90 (1)	62 (1)	84 (1)	81 (1)	102 (3)	49 (1)	8 (1)	
14	8	12	16*	6 (11)	20 (11)	20 (11)	22 (11)	23 (11)	34 (13)	25 (11)	38 (11)	40 (11)	61 (11)	64 (1)	81 (11)	61 (13)	65 (11)	82 (10)	102 (14)	51 (8)	7 (7)	
15	4	17	21	6 (15)	21 (15)	20 (15)	25 (15)	23 (15)	35 (16)	20 (16)	38 (15)	40 (15)	62 (15)	65 (15)	81 (15)	62 (16)	65 (15)	92 (15)	102 (17)	52 (9)	6 (11)	
16	..	11	12*	6 (10)	20 (10)	20 (10)	22 (9)	23 (10)	34 (12)	26 (10)	38 (9)	40 (10)	62 (10)	65 (10)	82 (10)	62 (12)	65 (10)	82 (11)	103 (10)	50 (8)	6 (3)	
17	1	8	9	6 (8)	20 (8)	20 (8)	22 (8)	23 (8)	34 (9)	26 (8)	38 (8)	40 (8)	62 (8)	65 (8)	81 (8)	62 (9)	65 (8)	81 (9)	102 (8)	53 (8)	7 (3)	
18	..	5	5	5 (1)	20 (1)	19 (1)	20 (1)	22 (1)	34 (5)	24 (1)	37 (1)	39 (1)	60 (1)	62 (1)	79 (1)	64 (4)	62 (1)	82 (4)	103 (1)	49 (1)	5 (1)	
19	..	3	3	..	..	15 (1)	..	..	35 (3)	25 (1)	37 (1)	..	..	..	..	64 (2)	..	88 (2)	..	..	..	..
21	..	1	1	5 (1)	19 (1)	20 (1)	..	22 (1)	35 (1)	25 (1)	38 (1)	39 (1)	61 (1)	64 (1)	81 (1)	63 (1)	65 (1)	82 (1)	102 (1)	51 (1)	..	
Average.	..	..	..	6	20	20	23	23	34	26	38	40	63	64	81	63	65	83	102	51	7	
Variants.	..	..	..	49	47	50	45	47	90	57	55	47	47	47	47	70	47	53	57	34	32	

\* The total includes one or more specimens of undetermined sex.

TABLE XIII.—The Range of Variation of the Body-Dimensions in the three species, *Gadus lucus*, *Gadus minutus*, and *Gadus emarkii*.

SPECIES.	GIRTH.						DORSO-VENTRAL HEIGHT OF BODY.						Diameter of Eye.			Interorbital Space.		
	Pectoral.			At Anus.			Tail.			Pectoral.			At Anus.			Tail.		
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
<i>Gadus lucus</i> , . . .	63	60	55	69	62	55	15	14	13	27	24	20	28	26	22	6	5	5
<i>Gadus minutus</i> , . .	55	52	46	58	53	48	14	13	11	22	20	18	24	21	18	5	4	5
<i>Gadus emarkii</i> , . .	50	45	37	52	46	36	12	11	9	19	18	17	21	18	17	5	4	4

SPECIES.	GREATEST LENGTH OF FISH.												HEIGHT OF LATERAL LINE ABOVE LATERAL AXIS.						RAMI OF TAIL.					
	Ventral.						Pectoral.						At Anus.			At Pectoral Fin.			I. Dorsal.			I. Ventral.		
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
<i>Gadus lucus</i> , . . .	17	15	14	19	17	16	24	20	18	9	7	6	7	6	6	20	18	17	20	19	18	10	9	9
<i>Gadus minutus</i> , . .	16	14	12	18	16	15	19	18	16	7	6	4	7	5	4	18	18	17	18	18	17	8	6	5
<i>Gadus emarkii</i> , . .	16	14	10	22	17	16	..	..	..	6	4	4	6	4	3	18	17	17	17	17	17	12	9	8

SPECIES.	GREATEST HEIGHT OF UNPAIRED FINS.												DISTANCE FROM THE ANTERIOR POINT OF THE FISH.					
	1 D.			2 D.			3 D.			1 A.			2 A.			Eye.		
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
<i>Gadus lucus</i> , . . .	14	14	13	10	9	8	8	7	6	10	9	9	9	8	8	6	5	5
<i>Gadus minutus</i> , . .	13	11	9	5	5	5	..	5	..	6	5	4	5	5	5	6	5	3
<i>Gadus emarkii</i> , . .	10	8	6	8	6	5	5	5	5	5	5	..	4	4	..	8	6	5

SPECIES.	Ventral Fin.						Pectoral Fin.					
	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.	Max.	Av.	Min.
<i>Gadus lucus</i> , . . .	24	23	21	24	23	21	24	23	21	24	23	21
<i>Gadus minutus</i> , . .	24	22	21	24	22	21	24	22	21	24	22	21
<i>Gadus emarkii</i> , . .	25	23	21	25	23	21	25	23	21	25	23	21





VI.—ON THE TAY SPRAT FISHERY,

1905–1906.

By JOHN FLETCHER, University College, Dundee.

---

I regret to report that the Tay sprat fishing has again been a comparative failure. Only 1371 crans of sprats, including young herrings, were taken out of the river this season, as against 1348 crans during last season 1904–1905, and 14,966 crans during the season of 1883–1884.

The 1371 crans consisted of somewhere about 28 million sprats and young herrings, of which some 57 per cent., or 16 million, were sprats measuring from about 4·5 centimetres to 14·5 centimetres in length, and the other 11 million, or 42 per cent., were young herrings measuring from 4·3 centimetres to 17·5 centimetres.

The bulk of the fish were caught during the first half of November, and at that time the sprats were of large size and of first-class quality, and the prospects of a good fishing season, which were afterwards completely disappointed, appeared to be excellent. The large size of these sprats contrasted greatly with the much smaller and younger sprats of last season, and caused a striking difference in the relative numbers of fish per cran during the two seasons.

Last season the average number of fish per cran was 28,800, and this season it was 19,200 during the first half of November, and 24,000 during the rest of the season.

Most of the fish were sent off fresh to the various English markets; a fair proportion, however, were salted and shipped to Germany for sardine purposes, while a small fraction were either sold for manure or thrown into the river, mostly while the men were at the sparling fishing.

The 1371 crans of fresh and salted fish brought to the fishermen a sum of somewhere about £350.

During January and February, while the men were at the sparling fishing, it was often difficult and sometimes impossible to obtain accurate information regarding the quantities of young herrings and sprats captured along with the sparlings. The difficulty was mainly due to the great scarcity of fish, and to the fact that small quantities were being sent off from Newburgh by the fishermen themselves, whilst other small quantities were taken to the Dundee Fish Dock, situated at the extreme east end of the city.

I ascertained, however, that the number of sprat boats engaged at the sparling fishing varied from 1 to 20 during the latter half of December and the whole of January, and from 1 to 7 during February. Each boat during December and January brought in along with the sparlings from 1 bucket to 2 crans of young herrings and sprats per day, while during February the average quantity was only about 2 or 3 buckets per day.

Unlike last season, the Broughty-Ferry fishermen and the sprat fishermen paid no heed to the Board's recommendation of January, 1904, namely:—that both fishermen should observe a line of division drawn

between Broughty-Ferry and Tayport. On several occasions the Broughty-Ferry men drifted for winter herring as far up the estuary as the Tay Bridge, while the sprat men were several times from  $\frac{1}{4}$  to 2 miles below Tayport.

During the course of this season's fishing 40 samples of mixed sprats, young herrings, and other fishes were bought and examined. The samples consisted of :—

Young Herrings, . . . . .	17,115,	from 4.3cm. to 17.5cm.
Sprats, . . . . .	8,539,	4.5 „ to 14.6 „
Young Sparlings, . . . . .	600,	4.2 „ to 15.0 „
„ Whiting, . . . . .	398,	7.9 „ to 19.9 „
„ Cod, . . . . .	215,	7.2 „ to 16.0 „
„ Plaice, . . . . .	54,	4.3 „ to 15.0 „
„ Dabs, . . . . .	50,	3.8 „ to 13.0 „
„ Flounders, . . . . .	19,	5.0 „ to 10.0 „
„ Saithe, . . . . .	17,	12.0 „ to 16.0 „

---

27,007

---

<i>Agonus cataphractus</i> , . . . . .	109
<i>Ammodytes tobianus</i> , . . . . .	70
<i>Liparis montagui</i> , . . . . .	70
<i>Gobius minutus</i> , . . . . .	70
<i>Syngnathus</i> , sp., . . . . .	9
<i>Cottus scorpius</i> , . . . . .	7
<i>Gasterosteus spinachia</i> , . . . . .	4
<i>Centronotus gunnellus</i> , . . . . .	3
<i>Gasterosteus aculeatus</i> , . . . . .	1
<i>Petromyzon fluviatilis</i> , . . . . .	1

---

344

---

The numbers of young cod, whiting, plaice, dabs, flounders, and saithe are somewhat larger than is shown in the above Table, owing to the fact that the daily catches are to some extent picked before and sometimes after being brought into the Dundee Tidal Harbour. Large quantities of leaves, rushes, and weeds of all kinds also enter the nets, and even branches of trees, which sometimes cause great damage to the nets, and the picking and throwing overboard of this rubbish and of the young fish entails a great amount of labour to the men.

During the first half of the month of November, while the fish were abundant and the percentage of sprats remained over 70, the number of other fishes caught along with the sprats was quite insignificant.

A typical unpicked sample of the fish consisting of :—

Sprats, . . . . .	1057
Young Herring, . . . . .	86
„ Saithe, . . . . .	1
<i>Agonus cataphractus</i> , . . . . .	1
Shrimps, . . . . .	1

---

1146

---

The above sample represents about one-seventeenth part of a cran.

On the other hand, during December, January, and February, when the fish were very scarce, and the percentage of young herrings very high, a typical unpicked sample of the fish consisted of:—

"Halflin" Herrings, . . . . .	16
Young Herrings, . . . . .	2218
Sprats, . . . . .	54
Young Cod, . . . . .	38
„ Whiting, . . . . .	35
„ Sparlings, . . . . .	416
„ Saithe, . . . . .	5
„ Plaice, . . . . .	12
Sand-eels, . . . . .	25
<i>Gobius minutus</i> , . . . . .	21
<i>Liparis montagui</i> , . . . . .	11
<i>Agonus cataphractus</i> , . . . . .	11
Shrimps ( <i>Crangon vulgaris</i> ), . . . . .	600

There were also present in this sample about 200 larval fish, consisting of over 90 per cent. young herring and about 10 per cent. of young sprats, sand-eels, and sparlings.

The whole of the above sample represents about one-twelfth part of a cran. The 40 samples of sprats and young herring examined during this season represented about one-thousandth part of the entire season's catch.

The catch was carefully examined on every day when the fish were landed at the Dundee Tidal Harbour, but on some days no large samples of sprats and herring were bought or examined, a rough estimate only being made of the proportion of sprats and herring which made up the catch.

By these two methods the following Table has been drawn up, showing the approximate composition of the catch throughout the season.

An asterisk denotes the days when the estimate was only a superficial one:—

Date.	No. of Crana.	Estimated No. of Young Herring.	Estimated No. of Sprats.	Estimated Total No. of Fish.
1905.				
October . . . .	1½	25,200	10,800	36,000
November 1 . . .	1	16,800	7,200	24,000
„ 2* . . . .	1½	15,000	15,000	30,000
„ 3 . . . .	8½	61,200	142,800	204,000
„ 6 . . . .	186½	250,992	3,334,680	3,585,600
„ 7* . . . .	56	107,520	967,680	1,075,200
„ 8 . . . .	105½	243,072	1,782,528	2,025,600
„ 9 . . . .	168½	647,040	2,588,160	3,235,200
„ 10 . . . .	40½	186,624	590,976	777,600
„ 11* . . . .	53½	308,160	719,040	1,027,200
„ 13 . . . .	126½	1,360,128	1,068,672	2,428,800

Date.	No. of Crans.	Estimated No. of Young Herring.	Estimated No. of Sprats.	Estimated Total No. of Fish.
November 14* . .	27½	264,000	264,000	528,000
„ 15 . .	121	998,976	1,324,224	2,323,200
„ 16* . .	57	492,480	601,920	1,094,400
„ 17 . .	20	192,000	192,000	384,000
„ 18* . .	19½	331,800	142,200	474,000
„ 20* . .	10	192,000	48,000	240,000
„ 21 . .	14½	331,740	10,260	342,000
„ 22 . .	20	441,600	38,400	480,000
„ 23 . .	¾	8,640	2,340	18,000
„ 24 . .	56½	404,484	688,716	1,093,200
„ 25 . .	71½	1,539,000	171,700	1,710,000
„ 27 . .	33½	454,860	343,140	798,000
„ 28* . .	19½	277,200	184,800	462,000
„ 29 . .	16	268,800	115,200	384,000
„ 30 . .	17	367,200	40,800	408,000
	1,251½	9,761,316	15,390,684	25,152,000
December 1* . .	½	10,800	1,200	12,000
„ 4 . .	8	134,400	57,600	192,000
„ 5 . .	6	100,800	43,200	144,000
„ 7* . .	1½	29,400	12,600	42,000
„ 9 . .	½	8,400	3,600	12,000
„ 11 . .	7½	130,200	55,800	186,000
„ 12* . .	½	8,400	3,600	12,000
„ 13 . .	10½	188,800	57,200	246,000
„ 14 . .	19	364,800	91,200	456,000
„ 15 . .	4	85,400	10,600	96,000
„ 16 . .	½	10,800	1,200	12,000
„ 18* . .	—	900	100	1,000
„ 19-30 . .	24	460,800	115,200	576,000
	82	1,533,900	453,100	1,987,000
1906. January 1-31 . .	30	576,000	144,000	720,000
February 1-24 . .	5	96,000	24,000	120,000

1905-1906.

Months.	Estimated No. of Crans	Estimated No. of Young Herring.	Estimated No. of Sprats.	Estimated Total No. of Fish.	Estimated Percentage of Young Herring.
October, . .	1½	25,200	10,800	36,000	70·0
November, . .	1,251½	9,761,316	15,390,684	25,152,000	38·8
December, . .	82½	1,533,900	453,100	1,987,000	77·6
January, . .	30	576,000	144,000	720,000	80·0
February, . .	5	96,000	24,000	120,000	80·0
	1,371½	11,992,416	16,022,584	28,015,000	42·4

With regard to the relative percentages of young herrings and sprats, I would point out that there is every indication that when a larger body of fish than usual enter the Tay estuary the percentage of sprats is usually very high; this was certainly the case during the past season 1905-6, but was not quite so noticeable during the previous season of 1904-5. It is also, of course, of equal importance to note that when fish are comparatively scarce in the estuary it is due usually to the falling-off in the numbers of sprats—in other words, whilst young herring are always present in the Tay estuary the larger shoals of sprats are only occasionally present.

The destruction of young herrings and other fishes is, therefore, not so alarmingly great as one would imagine it to be on first looking at the samples and the tables of percentages, and does not, in my opinion, argue for any drastic changes in the mode of fishing.

The fishermen, however, should not persist in fishing when the percentage of sprats falls below 60, and when the fish are of small size and not of much use for purposes of food.

The sale of fish for manure purposes should, I think, also be strictly prohibited, even when the fish are unusually abundant and the percentage of sprats very high.

During the course of the two past winters over 40,000 sprats and young herrings have been carefully measured with the object of ascertaining the probable age groups of both fish and the probable annual rate of growth. These measurements will be dealt with on another occasion.

#### GENERAL ACCOUNT OF THE SPRAT FISHING, 1905-1906.

This season's sprat fishing was late in beginning, later even than last season, and the lateness was again due to the great scarcity of fish. The regular sprat fishing of this season began on the 6th of November and practically came to an end during the latter half of December; it was taken part in by the same number of boats, and by practically the same number of men as last year.

The two main features of this season's fishing were (1) the excellent quality of the sprats whilst they remained plentiful in the estuary, and (2) the great scarcity of both sprats and young herring during the latter half of December and the whole of January and February.

The quality of the sprats was the best seen in Dundee for some years, the catches during the first week of the regular fishing consisting of over

70 per cent. of first-class sprats, the number of young food fishes other than young herring forming only an insignificant fraction.

The sprats were mostly of large size, their average sizes varying from 9·8cm. to 12·5cm., and contrasted greatly with the much smaller and younger sprats of last season.

Unlike last season, there was a keen demand for sprats throughout almost the whole of this season, and the usually brisk competition amongst the buyers kept the prices generally at a high standard.

In consequence of the good prices which the fishermen obtained for their fish, there was less dissatisfaction amongst them than last year, but there still remained great discontent amongst the buyers, owing to what they consider the excessive railway rates charged for the carriage of the fish to the various English markets.

The complaints of the fishermen gradually increased, however, as the fish became scarcer, and much real distress prevailed again during January and February.

With regard to the great scarcity of fish during December, January, and February, some of the men thought it was because of the want of south-easterly gales, and others because of the weak tides, heavy spates, and frosty weather. I also interviewed a few old fishermen, some of whom had been all their days taking part in the various fishings on the River Tay, and one and all complained bitterly of the great scarcity of all kinds of fish in the River Tay at the present day. They attribute this great scarcity of fish to the general increase in the numbers of bleaching works, dye works, ink factories, paper mills, and taneries, and to the gradually increased sewerage from Perth downwards. They declare that 20 and 25 years ago fish of many different kinds were very plentiful in all parts of the river; salmon and trout were exceedingly plentiful, and great numbers of large black flounders were got all the way from Newburgh to Broughty-Ferry, and were particularly plentiful on the north side of the Middle-Bank, where they are now scarce and of a much smaller size. Large cod were also very plentiful in various parts of the estuary, and were occasionally captured in considerable numbers as far up the estuary as Invergowrie Bay. Plaice, dabs, brill, and other fishes were also in much greater numbers than at the present day. During that time—20 and 25 years ago—the sprat boats only numbered some half-dozen, but they quickly increased until they numbered somewhere about 30, and have remained at about that number for many years.

Here I must mention, in connection with the general scarcity of fish in the river, the bitter complaints of the sprat fishermen and the Broughty-Ferry fishermen, who allege that the barge and dredger men in the employment of the Dundee Harbour Trustees deposit large quantities of mud and filth in the vicinity of Monifieth Bay, and have thus completely destroyed excellent spawning grounds of the winter herring. The barges containing mud dredged from the Dundee and Tayport harbours are supposed to be towed out to the mouth of the river, but the fishermen assert that on the approach of darkness, or if there be the least sign of a storm outside, the mud is at once dumped down in the vicinity of Monifieth Bay. I advised the fishermen to communicate with the Fishery Board in connection with the matter, but found later that the Broughty-Ferry Town Council had been in communication with the Dundee Harbour Trustees, and that the latter had, in consequence, instructed their employees to convey all mud to the mouth of the river.

During the course of this season's fishing, I pointed out to several fishermen and buyers that the Fishery Board regretted the destruction of so many young herring and sprats in the Tay estuary, and I suggested

the general use of the drift-net instead of the usual bag-net; but both fishermen and buyers were unanimously of opinion that drift-net fishing for sprats in the Tay estuary was impracticable; the currents, they maintained, were far too strong, and the drift net would not capture nearly enough fish to enable both fishermen and buyers to earn a fair living.

I further pointed out to the buyers the possibility of the drift-nets capturing more sprats than young herring, because of the deeper, rounder, and more serrated bodies of the sprats, but one of the buyers assured me that he had seen, on several occasions, as many young herring as sprats captured in the drift-nets at other sprat fishing stations. I also, in the course of my visits to the harbour, pointed out to the buyers that the barrels they were using in conveying the fish to the various English markets were generally of too large a size, and that the fish before they reached their destination must be in a very pulpy condition, and many of them not of much use for cooking purposes.

I suggested as an alternative the general use of smaller flat boxes. The buyers admitted the barrels were far too large, but argued that smaller flat boxes would have to be made of much stronger wood, and this would only add to the weight and subsequent cost of the carriage of the fish.

I discussed also the question of the preservation and tinning of the sprats for sardine purposes, and one of the buyers—Mr. William Hepkine, a noted Anstruther herring curer and exporter—was of opinion that the question was worthy of every consideration, but pointed out that a business of this kind would require a large sum of money to set it agoing, and it would not very likely pay for a year or two, because practically the whole trade is at present in the hands of foreigners.

I learned also that some of the fishermen had bought preserving and tinning apparatus several years ago, but they only met with fair success, owing chiefly to the high prices of sprats during some seasons, and their poor quality and small size during other seasons. If sprats are to be used for sardine purposes they must be bought at or below 5s. or 6s. per cran, and they must be of a fair size and comparatively free from young herrings. Young herrings can, however, be sardined like the sprats, but they require more labour and expense, and are not nearly so palatable as the sprats themselves.

#### FURTHER NOTES ON THE NATURAL HISTORY OF THE SPRAT AND THE YOUNG OF THE HERRING.

Fairly large numbers of young herrings and comparatively small numbers of sprats appear to be present in the Tay estuary at all times of the year, but the larger shoals of full-grown sprats only occasionally.

The Tay estuary would therefore appear to be more of a natural nursery ground for young herrings than for sprats, but its usefulness as such is very much diminished by the enormous amount of impurities poured into the river.

Here, then, arise the two most interesting points in connection with the natural history of both fish, namely:—"Why do they enter our estuaries at all during the winter months, and what are the causes of the constant fluctuations in their numbers."

As I pointed out in last year's report, the question of food may safely be left out of account altogether, principally because of the ill-success which attended the examination of the estuarine waters for food material, and the almost complete absence of food material in the stomachs of both the sprat and the young herring.

Again, with regard to the tides, I am still of opinion that spring tides have no more influence in bringing the fish into the estuary than neap tides have. This opinion is against that of many of the fishermen, but I found that in 1904–1905 as many large catches of fish were made during neap tides as during spring tides, and that during the past winter, 1905–1906, the largest catches of the season were made during the lowest phases of the neap tides. Here we must bear in mind, however, that the greater strength of the spring tides undoubtedly adds to the capturing power of the bag-net.

Slight variations in the temperature of the air, I also find, have no marked influence on the movements of the fish, but prolonged frosts and subsequent colder waters of spates may drive at least the younger forms out into the sea again. Neither of these, however, account for the principal fluctuations in the number of fish in our estuaries.

Spawning may, of course, be left out of account altogether, as the sprats do not spawn in the estuary proper, and spawning does not take place until the spring and early summer months.

Storms, and especially south-easterly gales, on the other hand, are undoubtedly important factors to be taken into account; but that south-easterly gales do not always drive the fish into the Tay estuary may be easily seen by referring to the weather statistics of the two past sprat fishing seasons. I may point out, however, that a series of westerly gales sometimes drive many of the fish from the upper parts of the estuary, and may give rise to large catches of young herring.

It was after a week of storms and south-easterly gales when the largest shoal of sprats of the past season made its appearance in the Tay estuary; but a greater storm of wind and rain a few days afterwards made little or no difference in the numbers of fish in the estuary. The same remarks hold good for the sprat-fishing season of 1904–1905.

There only remains now the question of the constant persecution by numerous and varied enemies and the consequent inherent restlessness and timidity of both fish. As is well known, large shoals of cod, ling, whiting, dogfishes, mackerel, and other fishes feed upon the sprat and herring, and shoals of haddock devour the spawn of the herring in large quantities. Seals, porpoises, and dolphins and many sea birds are also well known to be formidable enemies; add to all these, then, the cannibalistic habits of the two fish themselves, and the great destruction made upon them by the sprat fishermen, and one cannot wonder at the great and constant fluctuations in the numbers of both fish in our estuaries.

A sudden shoal of cod, whiting, or dogfish, or an increase in the numbers of seals and porpoises, or even the occasional presence of a whale in the vicinity, will doubtless drive large shoals of sprats into our estuaries. Here I may mention that only a few years ago a large whale made its appearance in the Tay estuary, and during the same time the water was simply teeming with sprats, young herring, and young whiting. I may also mention that both porpoises and dolphins are not uncommon just outside the river, and seals are sometimes very plentiful even in the estuary.

This incessant persecution, then, by numerous and varied enemies, may well explain the presence of the sprat, at any rate in such large and varying numbers, in our estuaries.

From the preceding remarks one could naturally conclude that a diminution in the number of enemies would result in an increase in the numbers of sprats and herring, and that both fish, especially the sprat, would in consequence remain further and longer away from our estuaries.

Again, during other seasons, when perhaps cod, whiting, dogfishes, and



so on, are very abundant, the numbers of sprats and young herring in our estuaries would very likely be much greater, although the actual total number of both fish in the sea would rapidly grow less. In this way, then, we may find a possible explanation of the occurrence of fat and lean fishing seasons in the various sprat fisheries round our coasts.

In connection with the above ideas I interviewed several fishermen and buyers belonging to Dundee, Broughty-Ferry, and St. Andrews, and obtained information from them which went to support my theories.

I found that very few sprats and young herring had been present in St. Andrews Bay during the autumn months of 1905, and that little or no cod were caught there during the same time. After, however, a week of storms in the North Sea, a large shoal of sprats, unmixed with young herring, made its appearance in St. Andrews Bay on the 2nd or 3rd of November, 1905, and large numbers of cod and whiting were being caught there at the same time.

All the cod, the fishermen informed me, were simply gorged with sprats, and many of the cod were vomiting up the sprats whilst being hauled on board.

This large shoal of sprats made its appearance in the Tay estuary about the same time as it did in St. Andrews Bay, and on the 6th of November the largest catch of the season—namely, 186½ crans—was made by the Tay sprat fishermen.

Another, if not greater, storm of easterly gales and rain took place on the 13th November, 1905, and caused great loss and damage to fishing apparatus in St. Andrews Bay. It also completely cleared out all the cod and codling as well as the sprats in the bay, and since that date, and until the close of the sprat fishing season towards the end of the following February, the fishing in St. Andrews Bay was a complete failure.

This great storm caused little or no increase in the numbers of sprats in the Tay estuary, so that the bulk of the St. Andrews Bay sprats must have sought shelter elsewhere.

Following closely upon the disappearance of the cod and codling from St. Andrews Bay, or in the course of the next two or three days after the storm, the Tay sprat fishing almost suddenly fell away and became a complete failure, and, further, it remained a failure along with the St. Andrews Bay fishing until the close of the Tay sprat fishing season.

I also found, upon further inquiry, that the season of 1904–1905 was a poor cod and codling fishing season in St. Andrews Bay, and this, of course, entirely coincides with the poor and unproductive sprat fishing in the Tay estuary at the same time.

With regard to the difference in the quality of the sprats during the two past seasons, it may be that owing to the mildness and exceptional dryness of the season 1904–1905 the younger forms of the sprat were enabled to remain much longer and much more constantly in the Tay estuary than usual, and that the cold and heavy spates of the past season 1905–1906 drove the younger and smaller forms of sprats out into the sea. These and like questions, however, can only be answered by observations and experiments extending over a period of several years, and require very careful scientific study.

#### NOTE ON THE EXTERNAL DIFFERENCES BETWEEN THE SPRAT AND THE YOUNG OF THE HERRING.

There is generally not much difficulty in distinguishing a sprat from a young herring, even when the external features are only taken into account and the internal structure left entirely alone.

The external differences, however, between the two fish appear so slight to a beginner that it takes him some considerable time to separate even small quantities of one from the other; and it is only after he has handled several thousands of fish, or has otherwise had long experience of them, that he is able to separate the one from the other with any degree of comfort and rapidity.

The proper method is, therefore, to first of all accustom the eye to the differences in the general shape and colour of the two fish; but to make sure, the thumb or forefinger must be drawn along the throats of the fish, when the sharp spines in the case of the sprat at once distinguish it from the comparatively smooth-throated young herring.

If in doubt about the general shape, colour, and spines, the position of the pelvic fins in relation to the first ray of the dorsal fin must be noted, and if still in doubt the number of rays in the pelvic fins themselves have to be counted.

In very small and semi-transparent fish the number of vertebrae have to be counted.

The following Table shows the general external differences between the two fish:—

	Sprat.	Young Herring.
General shape.	Deeper and narrower in the body. Belly curved from head to tail.	Relatively not so deep in the body, and much less curved in the belly; whole body usually more tapering towards tail.
Colour.	Narrow strip of slaty blue colour on back. Sides of body relatively more silvery.	Broader strip of greenish blue colour on back.
Head.	Short from snout to occipital region.	Relatively longer.
Spines.	Well developed on throat and belly.	Weak on throat and not so well developed on belly.
Eyes.	Small.	Relatively large.
Position of Pelvic Fins.	In nearly all fish above, but sometimes below, 5 cms. in front of first dorsal fin ray.	In nearly all fish above, but sometimes below, 5 cms. behind first dorsal fin ray.
Number of Rays in Pelvic Fins.	7, usually.	9, usually.
Tail.	Greyish in colour and usually ragged.	Darker fringe and more uniform in shape.
Vertebrae.	Not more than 48.	Not less than 54.

VII.—ON THE SPAWNING OF THE LUMPSUCKER (*Cyclopterus lumpus*) AND THE PATERNAL GUARDIANSHIP OF THE EGGS. By Dr. T. WEMYSS FULTON, F.R.S.E., Superintendent of Scientific Investigations.

(PLATE XI.)

The lumpsucker is a common fish on our shores in spring, when it comes close in among the rocks to deposit its spawn, the spawning-season extending from February to nearly the end of May. Its food consists of marine worms, coelenterates, crustacea, and small fishes; Dr. Murie has taken 100 whitebait (young herrings and sprats) from the stomach of a specimen.\* It is stated by several authors that the stomachs of females, especially, often contains nothing save a quantity of fluid; this is no doubt owing to their being mostly caught during the breeding season, when food is usually not taken by fishes.

The males are much smaller than the females and somewhat more numerous; they are brightly-coloured red on the fins and lower surface during the spawning time, while the females are dark leaden blue or slaty-coloured. The mass of eggs produced by a female is large, and may reach as much as 35 per cent. of the total weight; the average for three specimens examined by me was 27 per cent. In a female, 14½ inches in length and weighing 6 lbs. 12 ounces, caught on 16th May, and included in the following table, the eggs weighed 2 lbs., while 150cc. of ovarian fluid escaped from the ovaries.

The eggs measure about 2.2mm.—2.6mm., and have a volume of 4.18cc.; I found them to number from 79,758 to 136,764 in females a little over 18 inches long. The fecundity of the lumpsucker is therefore high. When examined in the ripe female before extrusion they are usually reddish or salmon-tinted, but may be lilac, pale violet, pale brown, or pink. On extrusion they are pink, but this tint fades on exposure to light, and gives way to a faint greenish or yellowish hue; later they become dark, owing to the development of pigment in the embryos.

The whole of the eggs are laid at one time, or at all events this appears to be the usual occurrence, but an examination of the ovaries of the females included in the Table below tends to show that it does not always happen, as several of them were found to be only partly spent. One of the females referred to in this paper, moreover, deposited her eggs in two lots after an interval of thirteen days. The eggs in the ovary, just before extrusion, are bathed in a plentiful fluid, but they are not adherent; when the fingers are passed through the mass, the feeling conveyed resembles that of contact with a mass of half-boiled sago. Around the eggs the secretion is syrupy, and on separating them glutinous threads pass between them. This substance hardens in sea water and binds the eggs into a large compact spongy mass, leaving narrow channels between by which water enters. It is doubtful, as we shall see, whether this arrangement would not be fatal to many of the eggs were it not for the constant attention of the male fish; and perhaps the same attention is given by the parents of other shore forms whose eggs are laid in adherent masses.

\* M'Intosh mentions annelids (*Nereis*), *Third Annual Report*, p. 60; Parnell says it feeds on worms and small fish, *Fishes of the Firth of Forth*, p. 382; Scott found coelenterates (*Beris*, *Pleurobrachia*) annelids, and crustacea, in their stomachs, *Twentieth Annual Report*, p. 467; Murie's observations are given in *Report on the Sea Fisheries of the Thames Estuary, Part I.*, p. 139.

These masses of eggs may be found attached to rocks, &c., about low water mark.

In the following Table I give the measurements and other particulars of 69 lumpsuckers taken from a salmon stake-net in the Bay of Nigg in spawning a few years ago, between 2nd May and 24th July.

Date.	FEMALES.			MALES.		
	Length.	Weight	Sexual Condition.	Length.	Weight.	Sexual Condition.
	Inches.	Lbs. oz.		Inches.	Lbs. oz.	
May 2	18	7 1	Ripe	10	1 4	Ripe
" 3	14	5 4	"	10	1 5	"
" 7	18	8 1½	Nearly spent	14½	3 6½	"
" -	14½	5 6	Ripe	12	2 5½	"
" -	17½	7 9½	Nearly spent	11½	2 0½	"
" -	18½	10 7½	"	12	2 4½	"
" -	17	6 14½	Spawning	11½	2 4	"
" -	17½	7 1½	Spent	9	... 15½	"
" 8	16	7 4	Spawning	...	...	...
" 10	17	6 6	"	12	2 9½	Nearly spent
" -	16	5 14½	"	...	...	...
" 12	15	6 15½	Ripe	11½	2 2½	Ripe
" -	14½	4 3	Spent	10½	1 7½	Nearly ripe
" 14	...	...	...	13½	2 7	Ripe
" -	...	...	...	10½	1 7½	"
" -	...	...	...	7½	... 11½	Nearly ripe
" 15	19	9 12	Spawning	...	...	...
" -	14½	5 6	"	...	...	...
" 16	18½	9 8	"	...	...	...
" -	14½	6 12½	"	...	...	...
" 17	15½	5 10½	Ripe	...	...	...
" -	14½	4 1½	Spent	...	...	...
" -	14	3 12½	Nearly spent	...	...	...
" 18	17	7 7½	Ripe	...	...	...
" -	15½	4 1	Spent	...	...	...
" -	15½	5 7½	"	...	...	...
" -	14½	5 13½	Ripe	...	...	...
" -	18	8 12	"	...	...	...
" -	15	6 14½	"	...	...	...
" 19	15	6 2	Spawning	11½	2 3½	Ripe
" -	...	...	"	12	2 2½	"
" 20	14½	5 14½	Ripe	13	2 13½	Nearly spent
" -	16½	6 4½	Spent	10½	1 12	Ripe
" -	17½	10 12	Ripe	...	...	...
" -	14½	6 0½	"	...	...	...
" 21	16½	9 2	"	15	4 6	Ripe
" -	16	7 0½	Nearly spent	8½	... 10½	Nearly ripe
" -	14	4 1½	"	...	...	...
" -	14½	4 1½	"	...	...	...
June 7	16	5 ...	Spent	...	...	...
" 8	14½	5 9½	Nearly spent	...	...	...
" 11	15½	5 1	"	10½	1 12½	Immature
" 13	11	2 2½	Quite Im'ture	7½	... 11½	"
July 3	...	...	...	10½	1 5	"
" -	...	...	...	9½	1 7	"
" -	...	...	...	11	1 11½	"
" 11	...	...	...	12½	2 7	"
" -	...	...	...	11	1 13	"
" -	...	...	...	10	1 7	"
" -	...	...	...	10½	1 2½	"
" 24	...	...	...	10½	2 4	"
Average, -	15.8	6 6	...	11	1 14	...

There were 39 females and 30 males. The females ranged in length from 19 to 11 inches, but the latter specimen was immature, the smallest female which was mature measuring 14 inches (35.5 cm.) and the weight of the mature females ranged from 10 lbs. 12 oz. (4871 grammes) to 3 lbs. 12½ ounces (2113 grammes), but this specimen had got rid of most of its eggs. The average length of the 39 females was 15.8 inches (about 39 cm.) and the average weight 6 lbs. 6 oz. (2889 grammes).

The length of the males varied from 15 inches to 7½ inches, the smallest ripe being 9 inches (23 cm.); the weights ranged from 10½ oz. (290 grammes) to 4 lbs. 6 oz. (1982 grammes); the former was not quite mature, the minimum weight of the males that were certainly spawning being 15½ oz. (432 grammes). The average length of the 30 males was 11 inches (28 cm.) and the average weight 1 lb. 14 oz. (822 grammes.) The difference in the size of the males and females is thus striking.

In June all the fish were spent or nearly so, and in July they were all immature. No female was obtained after 13th June, no doubt because they withdraw probably to deeper water, and the last male was got on 11th July, though the net was examined up to the middle of August.

One of the habits of the lump sucker well known to fishermen is the guardianship by the male of the mass of eggs after they are deposited. The habit was long ago accurately described by Fabricius in his description of the fishes of Greenland, and it has been referred to since by most writers, though often with scepticism. Couch, for example,\* is of opinion that the description of Lacépède to this effect is exaggerated, and that the presence of the male near the eggs is accidental. M'Intosh has given a graphic and pathetic picture of the male remaining on the beach guarding the eggs in a mere runlet of water after the tide had withdrawn from them.†

The authors of "Scandinavian Fishes,"‡ quoting from Malm, state that a fisherman of Bohuslän, named Johan Persson, had observed the spawning of this fish for three years in succession in the same cleft of the rocks at a depth of three or four fathoms; that the male posted himself a couple of feet away and "blew on the roe," besides defending it from enemies, defeating the attacks even of the crab. This habit of "blowing" upon the roe seems to have escaped the notice of naturalists; but from what follows it will be seen that the observation of the Swedish fisherman was quite accurate, and that an important part of the duty of the male taking charge of the eggs is to spout currents of water from his mouth on them.

I should think there are few better instances among fishes of parental devotion to the progeny than what is shown by the male lump sucker. For weeks and months he devotes himself to the nursing of the eggs with the most remarkable assiduity, refusing to be driven or seduced from his post; fasting and rejecting food until almost the end of his long and trying vigil: "blowing" upon them and fanning them with his fins all the time to keep them well aerated and clean; removing anything that might injure them, and defending them with courage and even ferocity from the attacks of foes great and small. When his task is ended and the eggs are hatched it is not wonderful that he is worn-out, thin, and exhausted with his zealous labours.

Last spring four living lump suckers were obtained from the local salmon stake-nets and brought to the Laboratory, and as two were males

\* "British Fishes," II., p. 187.

† *Ann. and Mag. Nat. Hist.*, XVIII., 5th Series, p. 81; *Ann. Rep. Fishery Board for Scotland*, Part III., p. 174; M'Intosh and Masterman, "British Marine Food Fishes," 183.

‡ Vol. I., p. 297.

and two were females, and the latter were evidently full of eggs, the opportunity was taken to make some detailed observations as to the spawning and the guardianship of the eggs by the male. The two females were first procured, and a few days afterwards the two males, and they were all put together in a tank, in which were also a number of small flounders, a few small plaice, and a lobster which had been there for a long time and dwelt by day in a hole under a stone at the back.

The concrete tank measures  $5\frac{1}{2}$  feet long by 4 feet 4 inches wide, and is  $3\frac{1}{2}$  feet high; it is provided with plate glass in front and back, and during the observations the height of water was maintained at 27 $\frac{1}{2}$  inches, so that the quantity of water was about 336 gallons (1663 litres). The flow amounted approximately to 80 gallons per hour. Since light is admitted to the back of the tank by a window narrower than the tank, and partly under the level of the ground, the back corners are not so well illuminated. The outflow from the tank was so arranged at first that the water had to pass first through a layer of sand around the lower end of a large fireclay pipe standing erect on the bottom, and high enough to reach above the surface, then up the inside of this pipe till it reached a lateral hole in the iron outflow pipe, which passes through the concrete bottom of the tank and is enclosed by the fireclay pipe.

On the morning of 24th March it was found that both the female lumpsuckers had spawned. Two large masses of eggs had been deposited during the night, in close contact with one another, in the left-hand corner of the tank, in front, against the glass, and between the side of the tank and a stone, on the top of which a large sea anemone was fixed (see figure on plate XI.). It was thus in a good position for observation. So closely were these masses applied to one another that they appeared at first to form a single mass, distinguishable only by a difference in tint. Later, when the eggs were nearly ready to hatch, they were separated throughout by an interval or gap of about half-an-inch, showing that the masses had in reality not been adherent to one another. It may therefore be surmised that though both females spawned during the night, 23rd–24th March, an interval of time elapsed between the layings; and, further, that the adhesiveness of the eggs is soon lost in sea water.

Both clumps of eggs were pink at first, but one lot was much paler than the other, and thereby readily distinguished.

After the females had shed their eggs they retired to the shadiest spots at the back of the tank, and passed the time in clinging to or lying on large stones which were there. They were sluggish and quiescent, scarcely moving, and at this time they took no food. Their system was no doubt much upset by the sudden ejection of so large a mass of eggs, which they had carried for some months.

The two males, on the other hand, occupied very different positions, both as regards their place in the tank and as regards their place in the social or domestic polity of the lumpsuckers present. One of them lay close to the masses of eggs; the other was as far from them and his fellow male as he was able to get, clinging to the wall of the tank in quite the opposite corner, and near the surface of the water, from which he often pushed his snout.

The former was guarding both masses of eggs. He was lying behind them, with his snout against them, and obviously keenly attentive to his surroundings as well as to the responsible duties of his office. The movement of another fish in the water, or of a person standing in front of the glass plate of the tank was sharply watched. If the hand or face or a handkerchief was approached towards the glass, the little lumpsucker came up over the eggs with eagerness and celerity, and remained there in

an attitude of watchfulness. If the hand was placed on the glass near the eggs, he made a furious charge at it; with so much force, indeed, in the early days of his long guard, that he obviously hurt his snout.

This was repeated again and again, and day after day. If anyone entered the tank-house and came within five or six yards of the tank, he was observed by the alert little sentinel, who rose up and watched him. When the attendant bared his arm and plunged it into the water to place a flat stone behind the eggs (so that the actions of the fish might be better observed as he rested upon it at a higher level), his arm was charged with such fury that it was forcibly driven against the front of the tank. The guarding male showed the courage, ferocity, and tenacity of a bulldog, which, indeed, he somewhat resembled, with his ugly visage, heavy jaws, and restlessly moving eyes, the whites of which were often exposed and conspicuous against the dark colour of his cheeks. His capacity as a defender of the eggs lay more in his power of butting than of biting, for which his mouth is not well adapted. All attempts to drive him off were futile. When a stick was pushed down into the water towards him he shoved it away with his snout, or charged at it.

During the two months that the eggs were under his care, the patient and devoted parent never left them, except for a moment now and again to pursue the other male. He could neither be driven away by menace nor enticed away by guile. The most savoury mussels, which were greedily swallowed by the other lumpuckers, did not tempt him. On the contrary, if one were allowed to sink near him or the precious eggs, he took it in his mouth, swam rapidly towards the middle of the tank, and promptly ejected it there, returning immediately to his post. Until almost the close of his vigil he ate nothing.

His conduct towards the other occupants of the tank was very interesting. Occasionally a flounder would swim lazily and aimlessly round the tank. The moment it approached the eggs, the lumpucker turned swiftly towards it, and, if necessary, headed it off. Now and then he would make a sudden dash at the trespasser, who precipitately retreated. The flounders soon came to understand the position, and avoided the corner where the eggs were lying; they chose to occupy the other side of the tank, preferring the company of the old lobster, though he was in the habit of catching one of them by stealth occasionally and devouring it. His quiet, sly, diplomatic ways, though really more dangerous, were less alarming to them than the furious but harmless assaults of the lumpucker.

Of special interest was the conduct of the two males towards one another. By rights, it may be supposed, and under ordinary circumstances, each mass of eggs would have been guarded by a male fish, and probably fertilised by him alone. But owing to the two females having laid their eggs in the same corner—for whatever reason—a conjoined guardianship was only possible if friendly feelings existed between the two males. This was far from the case. The male which had obtained possession of the eggs showed throughout the whole period the most rancorous and persistent animosity to the unattached one. The latter, on the other hand, displayed the greatest fear of his successful rival.

It may be supposed that in the night when the females were spawning, or about to spawn, the two males engaged in a combat or contest for the privilege of fertilising the eggs and guarding them. The one which was worsted in the nuptial fight never regained courage to attempt further contest for his rights, but displayed a most craven spirit from first to last, lurking in the darkest part of the tank as far from his rival as he could get.

It was sometimes possible, but always difficult, to drive or push him in the direction of the other male by means of a stick. He was more

readily enticed by holding mussels in front of him under the surface of the water, when he would swim after them as they were slowly withdrawn; but, though very fond of mussels, his fear of the other male usually subdued his appetite before he had gone very far, and he turned back.

Whenever the guarding male saw his late opponent moving, even a comparatively little way from his retreat, he rushed at him with the utmost fury—I was not previously aware that so clumsy and usually sluggish a fish could swim so fast—and the other male made off with equal speed, and often attempted to jump out of the water, or was partly knocked out. On such occasions so much commotion was made that waves were created in the tank and the other fishes were alarmed. These were the only occasions that the guardian left the eggs for a few moments. The animosity was kept up during the whole period of the experiment, a fact which is of some interest.

The females took no part at all at any time in looking after the eggs, as some authors have supposed them to do. They lay indolent and quiet at the back of the tank for some days. On the 2nd April, one of them began to swim about and come to the surface. She took not the least notice of the eggs or of the males, nor the males of her. Even when she came so close to the eggs as to brush them with her fins, the male merely looked at her, or moved a little aside to let her pass.

On the 5th April, a second deposit of eggs, comparatively small in quantity, was observed, laid over the top of one of the other clumps. It had been deposited during the night by one of the females. Three of the usual dimples or cup-like depressions were noticed on the surface of them, caused no doubt by the fondling snout of the male.

On the 15th April, attempts were again made to induce the sentinel male to eat mussels. He took no notice of those dropped at some distance; if they came near, or fell on the eggs, he seized them, swam a foot or two away, and ejected them. Very different was one of the females, who devoured them in great numbers, as did also the other male, if within what may be called his safety-zone, all his actions being dominated by fear of the guarding male. The second female, perhaps the one which had recently deposited the eggs referred to, still lay quiescent at the back of the tank, and did not attempt to seize mussels. The active female showed the greatest indifference to the lobster, and when by accident she touched his open claws he merely withdrew a little further into his hole.

From the first, the guarding male was observed to fan gently the mass of eggs with his breast fins, clearly for the aëration of the eggs, but for some time the action was leisurely performed and was by no means so striking as it became later. It is certain that the duties of the male is not confined to guarding the spawn from foes, but that an important part of them include the aëration of the eggs by creating currents through the mass, and the keeping of them clean. It is indeed a little surprising how a sufficient supply of oxygenated water can reach the interior of the compact mass by the narrow and tortuous channels which exist between the adhering eggs. The mass may be six or seven or more inches in diameter. It is probable that under natural circumstances the surging movement of the tides is the most influential agent in effecting this. At all events, from the early part of April onwards, the male lump-sucker kept fanning the spawn with more zest than at first. And on the 10th April another action was for the first time observed. Placing his mouth about an inch or so from the spawn he spouted water out upon it, the action of the gill-apparatus being thus reversed, as I have observed also in plaice with their snout above the level of the water.\*

\* *Twenty-second Annual Report*, Part III., p. 287.



This curious action was most purposive and effective. The current created was so strong as to sway the algæ growing on the side of the tank in the neighbourhood as well as the tentacles of the anemone, and even to cause the whole mass of eggs to rock visibly backwards and forwards. This action was done at brief intervals and from this time onwards. Later, when the eggs were hatching it was redoubled, and great activity was shown with the fins. The movement thus created in the water very probably helped the escape of the larval fishes from the eggs. At this time the "pumping" or "blowing" action was at the rate of fifteen or sixteen in ten seconds, and in the pauses the fins were kept vigorously at work.

On April 17th, I tried an experiment. I removed the devoted lumpsucker in a dip-net and placed him in an adjoining tank of the same dimensions, in which were a few dabs (which were greatly alarmed). After turning round once or twice, as if to get his bearings, he swam towards the corner where he expected the eggs to be and paused about a foot away. He then swam up to a stone at the back of the tank and paused again; he next moved restlessly all round the tank, and came back once more to what appeared to be the familiar corner; then he moved slowly towards the other corner and lay quietly on the bottom, having apparently abandoned the quest.

Meantime, I endeavoured to get the other male to undertake the guardianship of the eggs. He was driven gradually to the corner where they lay, and paused a moment, but rather, it may be conjectured, with surprise at the absence of his foe than from any impulse to attend to them. The experiment was repeated with a like result, no inclination being shown by this male to assume the duty. Whether he would have done so later may only be conjectured. Finally, I placed this male in the other tank beside the proper guardian in order to see whether the latter would attack him in the absence of the eggs. He did not. He merely looked at him, without making any attempt to approach or pursue him. On the other hand, the newcomer recognised his enemy, and rushed off as before, but finding that he was not pursued, he soon settled down and approached the other male, who took not the least notice of his presence.

Both males were then put back into the tank containing the eggs. The guardian at once sought for them and resumed his duty, and with it also his animosity to the other male, and the old relationship was re-established.

Towards the end of April the conditions were the same as before, the sentinel lumpsucker "blowing" and fanning the eggs, refusing mussels, removing them from near the eggs if dropped there, chasing away wandering flat-fishes and relentlessly pursuing the other male, and coming up angrily and aggressively when one approached the front of the tank.

By this time the egg masses had become very dark, owing to the development of black pigment in the now well-advanced embryos. The masses at first, as stated, were pink; this tint faded and they appeared pale green, whitish, then dirty amber-coloured, and then dark, for the reason mentioned.

The colours of the males were also different. The one that was guarding the eggs, and had probably fertilised them, had lost his brightness and was dingy, while the other, who most likely had not spawned, possessed the red colour on his fins and lower part as vividly as at first.

More than a month had elapsed since the guarding male assumed duty, and during that time he had eaten nothing. He was looking thin and and was infested with ecto-parasites (*Caligi*), and appeared sometimes

exhausted by his onerous task and prolonged fast. That this was not entirely due to these causes was shown when the supply of water to the tank was increased, and when it was directed to his corner. After a refreshment of this kind he moved round about with vigour, energetically spouting water on the eggs and fanning them with his fins.

Towards the end of the month he took a mussel occasionally and swallowed it. This was first noticed on the 26th, and on some days he ate as many as five; any excess he carried off and ejected, as before; and at the beginning of May he was as alert, active, and pugnacious as ever.

On one day at this time I dropped on the top of the egg-mass a little common swimming-crab, about  $1\frac{1}{2}$  inches in breadth, which, apprehending danger, clung tightly in one of the snout-depressions on the surface of the eggs. It was amusing to watch the lump sucker ineffectually trying to rout him from the hollow in which he had taken refuge, the blunt snout of the fish preventing a hold being got on the crab. He tried again and again to dislodge or seize the crab. At last the crab turned partly on its side, and extended its widely-opened chelæ as if to defend itself, which gave the fish its opportunity. It seized the crab in its mouth and swam off with it to the furthest corner of the tank, where it dropped it.

Early in the experiment the outer fire-clay pipe was removed and an apparatus fitted up to the overflow, so that all the water leaving the tank passed through two boxes with fine silk-gauze bottoms. This was to retain the larval lump suckers when they issued from the eggs. The first of these was got on 5th May, 43 days after the eggs were deposited and fertilized. The daily temperature of the water during this period may be seen by reference to the tables on pages 113 and 284. When the eggs were spawned it was  $42.5^{\circ}\text{F}$ ; in April it varied from  $41.5^{\circ}$  to  $46^{\circ}$ ; and at the end of the month was  $43.7^{\circ}\text{F}$ . and  $45^{\circ}\text{F}$ ., rising to  $44.6^{\circ}$  and  $47^{\circ}\text{F}$ . in the first week of May.

For the first few days after the 5th, the tadpole-like larval lump suckers were found in small numbers in the overflow-filter every morning, and they slowly increased in numbers. They were very active, swimming with great rapidity by a lashing movement of the tail, a large yolk containing an oil globule at the right side being conspicuous.

At this time, as I have mentioned, the male parent was most assiduous in his attention to the egg-masses, redoubling his activities both in fanning and "blowing" upon the eggs. He ate mussels sparingly, sometimes fasting for a few days, and carrying off and ejecting the proffered food. He also continued to chase the other male and drive off intruders.

Up to the 22nd May, or almost exactly two months from the time the eggs had been spawned, and seventeen days after they had begun to hatch, the conditions described continued. The young lump suckers were appearing in greater numbers, but still not in such abundance as one might have expected. The largest number was about two or three hundred in a day. They were also to be seen adhering to the glass front of the tank, and numbers were thus accounted for. None were observed on the back of the male, a habit sometimes attributed to them.

It was now noticed, however, that many of the larval lump suckers were dead and white, and these were also seen floating in the water. On examination, it was found that the condition of the tank was unsatisfactory; it was obviously rather dirty from an accumulation of weed and refuse, and had probably too many occupants for the experiment, and when the egg-masses were examined their lower parts were found to be black and fetid, a circumstance that explained the presence of the dead and whitened young lump suckers. Clearly the aëration had not been sufficient for the interior of the egg-masses. The supply of water to the

tank was increased, but it was judged that that would not suffice, and the blackened parts of the spawn were torn off, the portions that seemed in good condition being replaced in their old position. The spell, however, was broken. The male did not resume his attention to the eggs, the mass of which was indeed much broken up and diminished in size. He pushed some of the pieces about the tank and withdrew. Both he and the eggs were placed in another tank, without any better result. He pushed the pieces about a little and left them. And when the other male was introduced, he seemed oblivious to its presence; his animosity, at first associated no doubt with reproduction and fertilisation, and then with the care of the eggs, had quite departed.

On examining the portions of the egg masses that remained, the surface was found to be flocculent from the empty egg-shells from which the young fishes had escaped, most of which were still attached to it. On the other hand, the interior of the mass was solid, the eggs all containing embryos, some of which had died, but many were subsequently hatched out in jars. From an early period some of the eggs, but not many, next the glass in front of the tank, were observed to be white and opaque (dead), but they did not decay.

The difficulty of hatching the eggs of the lumpsucker was pointed out previously by M'Intosh, who stated that in tanks they speedily acquire a fetid odour, that the death of a few causes putrefaction of the whole, and that they had not yet been hatched out in tanks.\* He does not give any particulars as to the dimensions of the tanks or the flow of water, but probably the chief difference between his experiments and that described here was that the male in the latter case was constantly engaged in tending the eggs, which shows how efficient that attention may be.

The hatching of the eggs, so far as it was accomplished in the tank under the care of the male, extended from the 5th to the 22nd of May, or seventeen days. The greater number were still unhatched on the latter date. It seems a long period, considering that the eggs were deposited, and no doubt fertilised, at practically the same time. Under natural circumstances, it is probable that the time taken for the hatching of all the eggs is prolonged, for it is difficult to understand how the larvæ could make their way from the interior of the mass by the narrow channels between the eggs if the eggs there were hatched as soon as those on the exterior. The condition of the masses shows that this does not occur, and that hatching proceeds from the outer surface inwards, a process which must take a considerable time. It seems very likely that the development of the eggs towards the centre of the mass is retarded, owing to defective or inferior aëration there, compared with the eggs on the surface and near it; and that this is related to the gradual disintegration of the outer surface as the eggs hatch there, and a pathway of escape is opened to the larvæ.

One could not fail to be impressed with the advantage to the species of this guardianship of the eggs by the male fish. Numerous foes must be driven off and the eggs preserved, and I do not think the story of Fabricius, that the lumpsucker under such circumstances will attack the wolf-fish, need be doubted. The courage and pugnacity of this usually docile and inoffensive fish seem boundless when it is protecting its eggs, and in contests of this kind it not infrequently happens that courage and determination count for as much as strength and the power of inflicting real injury.

The conclusions from the experiment may be thus summarised:—

- (1) The male alone defends the eggs, the female taking no part whatever in protecting them.

\* *Annual Reports Fishery Board for Scotland*, 3rd, p. 60; 14th, p. 272.

- (2) The guardianship is prolonged till the eggs hatch, probably till all are hatched, a period exceeding two months in duration.
- (3) The male not only protects the eggs from enemies, but is constantly engaged in cleansing and aerating them, both by the movement of his fins and by spouting currents of water upon them from his mouth.
- (4) He removes from them or their immediate neighbourhood foreign bodies which might injure them, and carries them to a distance.
- (5) The male fasts during at least the greater part of his long vigil, but begins to feed towards its close.
- (6) He drives away other males, and displays great animosity to them throughout the whole period.
- (7) This animosity is shown only when the eggs are present.
- (8) The period of incubation may extend over 40 days.
- (9) The hatching of the eggs is also prolonged and gradual, those at the surface of the mass hatching first, and those at the centre last; and this difference in the rate of development is probably correlated with a difference in the degree of aëration or oxygenation of the eggs, the better oxygenated hatching first.



The figure is a reproduction of a photograph taken by Dr. Williamson through the glass front of the tank, and shows the eggs and male *in situ*. The male lump-sucker (*a*) occupies a position which he often took up, adhering to the side of the tank above the eggs. His outline is somewhat blurred, owing to movement while the photograph was being taken. Very often he sat on the stone behind the eggs, part of which is shown at *b*. The egg-masses which he is guarding and attending to are shown at *c, c*. The anemone, which was his constant companion, is represented at *d*.



VIII.—ON THE RATE OF GROWTH OF FISHES. By T. W. WEMYSS FULTON, M.D., F.R.S.E., Superintendent of Scientific Investigations.  
(Plates XII., XIII.)

CONTENTS.		Page.
INTRODUCTION.		
Species Dealt With, ... ..		179
Methods, ... ..		180
Comparison Between Different Species, ... ..		180
Influence of External Conditions, ... ..		181
A Law of Growth, ... ..		182
Plaice ( <i>Pleuronectes platessu</i> ), ... ..		184
Common Dab ( <i>P. limanda</i> ), ... ..		189
Flounder ( <i>P. flesus</i> ) ... ..		191
Lemon Dab ( <i>P. microcephalus</i> ), ... ..		192
Long Rough Dab ( <i>Drepanopsetta platessoides</i> ), ... ..		196
Turbot ( <i>Rhombus (Bothus) maximus</i> ), ... ..		199
Brill ( <i>Rhombus lavis</i> ), ... ..		203
Cod ( <i>Gadus callarias</i> ), ... ..		209
Haddock ( <i>G. aeglefinus</i> ) ... ..		225
Whiting ( <i>G. merlangus</i> ), ... ..		227
Grey Gurnard ( <i>Trigla gurnardus</i> ), ... ..		229
Tables of Measurements, I.—XXV., ... ..		234

INTRODUCTION.

For a considerable number of years special attention has been devoted to the study of the growth of fishes by the scientific department of the Board. In 1889, I began observations on this subject by two methods, (1) by marking fishes (plaice, dabs, lemon dabs, brill, turbot, cod, &c.) by attaching to them brass labels bearing a number, the method which is now so largely used in connection with the international investigations, and then returning them alive to the sea; in the case of the herring, by removing a portion of the caudal fin; (2) by keeping the fishes in tanks, and noting the changes that occurred from time to time in their length and weight.\*

Since then very many fishes have been dealt with by another method—viz., by collating the measurements of large numbers of each species, by which the earlier series or generations can be separated from one another and the rate of growth ascertained, the measurements grouping themselves into curves or waves. This method was used to a limited extent by Miescher Ruesch in his classic studies on the salmon of the Rhine, and by other observers, as Ljungman, in studying the growth of the herring. These observers, however, did not classify the measurements in a scientific manner, which was first done by Dr. C. G. J. Petersen, who thus placed an important method at the service of investigators.

SPECIES DEALT WITH.

In the course of my investigation on growth during recent years, a large number of fishes have been dealt with—viz., nearly 209,000, belonging to 21 species. The results in regard to many of them have been given in a

\* "An Experimental Investigation on the Migrations and Rate of Growth of the Food-Fishes," *Eleventh Annual Report*, Part III., p. 117.

series of papers in the Annual Reports of the Board.\* The numbers of the various species measured for this work, and already dealt with, are as follows :—

Plaice, - -	17,950	Gurnard, - -	5,495
Common Dab, -	26,230	Norway Pout, -	7,192
Flounder, - -	231	Hake, - -	571
Lemon Dab, -	2,201	Herring, - -	19,806
Witch, - -	3,422	Sprat, - -	6,473
Long Rough Dab, -	20,261	Grey Skate, . -	432
Turbot, - -	212	Angler, - -	722
Brill, - -	807	Armed Bullhead, -	1,312
Cod, - -	7,176	Lesser Weever, -	417
Haddock, - -	28,760	Lumpenus - -	738
Whiting, - -	58,164		

Numerous measurements of other forms, as halibut, megrim, ling, pollack, coalfish, tusk, catfish, have also been made, and will be dealt with later.

Most of the fish were measured on board commercial steam-trawlers, engaged either in trawling investigations in territorial waters or in commercial fishing in the North Sea.

#### METHODS.

In a previous paper† I gave a full account, with illustrations, of the method adopted in collecting and measuring the fishes. Besides this method, there is no doubt that much may be learned by keeping fishes in confinement, and measuring and weighing them from time to time, for comparison with those obtained on the fishing grounds, and this has been done. Another method, referred to above—viz., labelling the fish—has also in certain cases given good results, most, perhaps, with flat-fishes. Recently a fourth method has been employed, especially in Germany, by the examination of the markings on the scales, otoliths or ear-stones, and bones. It has also been used in the international investigations in this country by Garstang and Wallace, with reference particularly to the growth of the plaice, and the results agree with those obtained by a study of the measurements.‡

#### COMPARISON BETWEEN DIFFERENT SPECIES.

While one general result of the investigations on the rate of growth of fishes has been to show that they do not grow so fast as was generally believed, it has been made clear that different species may increase at different rates, apart from differences in size. In fishes which undergo a marked metamorphosis, growth is sometimes, and perhaps always, slow, especially at early periods. It is thus with the plaice and other flat-fishes, with the eels, and with the herring and sprat. Among round-fishes, as the cod, the haddock, and the whiting, on the contrary, growth is comparatively rapid. A young haddock grows many times faster than a plaice.

With regard to the age at which fishes attain mature size and begin to reproduce, similar differences exist. So far as the investigation has gone,

\* 19th, 20th, 21st, 22nd.

† *Twentieth Annual Report*, Part III., pp. 226-334.

‡ North Sea Fisheries Investigation Committee. *Report (No. 2, Southern Area) on Fishery and Hydrographical Investigations in the North Sea and Adjacent Waters.*



no sea fish has been found to attain the mature condition in the first year of its life, or before the close of its second year. Some spawn for the first time at the end of their second year, *i.e.*, when two complete years of age. These, as a rule, are the smaller species, as the sprat, the armed bullhead, the Norway pout, and the lesser weever; but this class includes also the whiting, which reaches maturity with comparative rapidity.

Among those which spawn for the first time at the end of their third year must be included the haddock, though some of these may reach maturity at the close of two years, the common dab and the long rough dab. Amongst the latter two species, indeed, the male comes to maturity a year earlier than the female, when two years of age, a phenomenon common to most flat-fishes.

Thus, with the witch, the male matures at three years and the female at four years; among plaice the male matures at four years and the female at five. Among round fishes, on the other hand, the two sexes reach maturity at the same age.

The cod does not attain its mature condition before the completion of its fourth year, while such large flat-fishes as the turbot, halibut, and brill take a longer time—the turbot probably not before it is seven years old, and the brill not before it is five or six. The approximate age at which the angler first spawns is, as the minimum, four years for the male and five years for the female.

How many years fish live after they reach sexual maturity it would be difficult to decide; but it is certain that in most cases the duration of reproductive life greatly exceeds the immature period. The method of determining the age by a study of the measurements is not well suited to solve the question, owing to the fusion of the groups from the variations in the rate of growth, and it is here that the method of estimating the age by the markings or number of zones on the hard structures may be of special advantage. Fishes of a size above the normal limit for the species are very old. When dealing with the plaice in a previous report\* I remarked that the largest specimens I then described must be sixteen years old, but Professor Heincke, from an examination of the bones of the gill-cover, concludes that such individuals are twenty years old and more.

#### INFLUENCE OF EXTERNAL CONDITIONS.

Among the conditions which influence growth the most important, apart from quantity of food, appears to be temperature. Direct experiments on this point, by keeping fishes in water of different temperature, are described in the *Twenty-second Annual Report*, where it is shown that those in the water that was warmest grew much faster than those in colder water. Previous experiments in tanks,† in which the fish were retained over winter and supplied with water from the beach at the ordinary temperatures, proved that the growth of plaice of 13 and 14 inches and of dabs is almost or quite arrested in January and February. It has also been shown that the growth of small plaice and dabs on the beaches ceases in winter, and that among such round fishes as the haddock and whiting the retardation of growth is marked in the early months of the year, when the temperature is low, the growth of these fishes taking place mostly in a few months in summer.

With regard to the whiting, I have been struck with the attenuation shown by many individuals examined in the early part of the year, and I think it is not improbable that the storage of fat in the muscles and the liver of fishes during summer and autumn is not merely for supplying

\* *Twentieth Annual Report*, Part III., p 357.

† *Eleventh Annual Report*, Part III., p. 193.

material for the growth of the reproductive organs, as is commonly supposed, but is also connected with maintaining their nutrition over the colder portion of the year. Fat is often got in immature fishes in quantities, as in the herring and Norway pout, for example.\*

There are reasons for the belief† that growth is modified with respect to period and amount in the deeper waters of the northern part of the North Sea, compared with the waters near the coast, but to what extent the growth of fishes in the sea in deep and moderately deep water, as on the fishing banks in the North Sea, is affected by the changes in the temperature of the water is not yet clear, there being a want of sufficient observations as to the changes in the temperature that actually occur there.

It is clear that a knowledge of the changes in temperature that take place is necessary to understand not only the growth of fishes and its variation, but their biology generally. All the other observations ought to be correlated with the temperature changes, just as the biological changes on land are, and what is wanted is a calendar of physical conditions throughout the year to which the biological observations may be referred, whether they relate to plankton, food of fishes, spawning periods, development, growth, or migrations.

The salinity of the water is another condition which probably modifies growth to a considerable extent, and it is not unlikely that it is one of the causes which produce a change in the range of size and the average size in species in certain localities. Some fishes, as the plaice, the dab, and the lesser weever, I have found to be of smaller dimensions, and of slower growth, in the Solway Firth, where the salinity is reduced, than on the East Coast, and the same cause probably acts on other forms. The subject is one which has not yet been much investigated.

#### A LAW OF GROWTH.

During the researches on the growth of fishes, it has become apparent to me that there exists a relationship between the size at which sexual maturity occurs in the various species and the general maximum size to which they attain. It may be expressed in one way by saying that *fishes approximately double their size and increase their weight about eight times after they have reached sexual maturity*; or that *fishes attain sexual maturity when they reach about half their maximum length and about one-eighth of their maximum weight*.

It cannot be said at present that the law is more than approximately correct, for our knowledge of the precise average size at which the males and females of many fishes first spawn is as yet meagre—it is not well determined even for the cod—and the same is true as to the general maximum size to which many fishes attain; a limit, moreover, which, in some instances at least, may have been modified by the action of man. For example, the maximum size of most fishes at Iceland is larger than in the North Sea at present, though there is no reason to suppose that growth is quicker there; and it is known that when the Dogger Bank was first worked by trawlers the general maximum size for plaice was higher than it is now.

\* A research on this subject is at present being made for the Board by Dr. Noël Paton, whose investigation of the changes in the salmon are well-known, as well as one on the rate of digestion in fishes.

† *Twentieth Annual Report*, Part III., p. 394.

But the facts are sufficient to justify the statement in its broad sense, and doubtless the extensive investigations now being carried on will ere long show how far it may be incorrect. It is to be noted that it applies to the fish in a region in which growth is naturally modified; if plaice, for example, reach maturity in one region at a size less than in another, then the maximum size is also less. It is the same with the males and females among flat-fishes; the males, as a rule, attain the mature condition at a less size than the females, and their maximum growth is correspondingly curtailed. As the maximum size of a species of flat-fish is approached, the proportion of males diminishes and the proportion of females increases; and all the very large individuals are females.

I give in the following Table the information such as it exists for a number of species, the sizes being in inches:—

Species.	Approximate Size at Maturity.		Approximate Age at Maturity.		Approximate Maximum Size.		Exceptional Records of Size.	
	Female.	Male	Female.	Male.	Fema.	Male.	Female.	Male.
Plaice, . .	16-17	13-14	5	4	32	...	38½	...
Com. Dab, .	7½	6	3	2	15	13	17	...
Flounder, .	8-9	...	...	...	...	...	18	...
Lemon Dab, .	10	8	4(?)	...	20	...	...	...
Witch, . .	11-12	10-11	4	3	23	...	24½	...
Halibut, .	48	30	...	...	84	...	.	...
Megrim, .	12	9½	...	...	24	...	...	...
L. R. Dab, .	6½-7	...	3	2	13-14	12	16½	...
Turbot, . .	17-18	...	7	...	32	...	(70 lbs.)	...
Brill, . .	15	...	6	...	26	...	...	...
Cod, . .	26-27	...	4-5	...	45-58	...	68	...
Haddock, .	11	11	3	3	25	...	33	...
Whiting, .	8½-9	...	2	2	18	...	...	...
Norway Pout,	4½	...	2	...	8-8½	...	9½	...
Gurnard, .	9	...	3	...	17-18	...	...	...
Angler, . .	30	27	5(?)	4(?)	...	...	...	...

The approximate maximum size is as far as possible derived either from market measurements or from fish which have been measured on trawlers.

#### PLAICE (*Pleuronectes platessa*).

A considerable number of collections of plaice were measured, partly from Aberdeen Bay and the Moray Firth, as well as from the Solway Firth and Lochfyne; special attention being given to the small forms. The total number of plaice dealt with in this paper, whose measurements are given in the Tables appended is 11,385, making with those described in the previous paper an aggregate of 17,950.

## LOCHFVNE.

The small plaice taken in Lochfyne were obtained by the push-net on the beaches at low water, that is to say, in two or three feet of water at that period of the tide. Those dealt with here were got in July and August, 1901, and in June and July, 1903, the aggregate numbers being 4751 fish. They were taken at several different places in the loch, as shown in Tables I.-III. (p. 243), most being got at Inveraray, Strachur, Big Harbour, and Salen. They all belonged to the same series, the fry of the year, and consideration of their measurements gives an indication of the rate of growth at this stage in Lochfyne. Taking first of all the catches in July and August, 1901, it will be seen from the Tables that the push-nettings in July, which were made between the 1st and 6th of the month, resulted in the capture of a total of 3529 small plaice. The sizes ranged from 12mm. to 58mm., a difference of 46mm. The maximum numbers were ranged about 2.5cm. to 3cm., and the average length was computed to be 30.3mm. (Plate XII.).

The period in August when the collections were made was from the 28th to the 31st. The numbers were smaller, viz., 556 fish. They ranged in size from 34mm. to 88mm., a difference of 54mm. The greater numbers were ranged about 50mm., or more than 20mm. higher than in July, and the average size was calculated to be 55.9mm., or an increase of 25.6mm. (as near as possible, 1 inch) in the period, which may be placed at 58 days from the middle of the one series of collections to the middle of the other (Plate XII.).

It is noteworthy that in some of the collections, most noticeably in July, the plaice of one locality were sensibly larger than those of others, a fact that was pointed out at the time by Mr. Dannevig. Taking the four chief places at which collections were made in that month, the range and averages in millimetres are as follows:—

	Number of Fish.	Smallest.	Largest.	Average.
Inveraray, . . . .	1,163	19	58	35.9
Strachur, . . . .	668	16	51	28.9
Big Harbour, . . .	822	12	51	27.0
Salen, . . . .	806	14	51	26.1

[TABLE.

The contrast between two of the places may be brought out in the following manner by comparing the sizes at Inveraray and Strachur, reduced to percentages, the number of fish being in the former case 1163 and in the latter 668, and both series collected on the same days (*see* fig. 3, pl. xii.):—

Cm.	Strachur.	Inveraray.
1	—	—
.5	0.15	—
2	8.50	0.08
.5	37.90	2.90
3	35.90	25.50
5	11.80	37.40
4	4.20	20.40
.5	1.00	8.80
5	0.40	3.60
.5	—	1.10
6	—	0.08

It may be said that in August the average size and the minimum size were also larger at Inveraray than at Strachur, the average at the former place being 66.5mm. and at the latter 52.0mm., while the minimum sizes were 48mm. and 34mm. In the collections in June and July, 1903, the same feature is repeated, thus:—

	Date.	Number of Fish.	Smallest.	Largest.	Average.
Inveraray, . .	June 22	86	17	47	27.7
Strachur, . .	.. 24	94	15	29	19.94
Inveraray, . .	July 10, 11	105	17	50	30.4
Strachur, . .	.. 13	50	19	57	28.8

The explanation put forward by Mr. Dannevig to account for this difference was the probability that the temperature at Inveraray is higher than at Strachur, owing to the former locality being less affected by the deep-water tidal currents, and he pointed out that the size of the small plaice at the top or upper parts of the loch appears to be slightly greater than at the lower parts near the mouth. So far as the somewhat limited observations on the temperature are available they seem to show a rather higher temperature at Inveraray, as a rule, but not always.

The other collections referred to in the Tables were made in June and July, 1903. The period in June extended from the 22nd to the 26th, and the small plaice caught numbered 218. They ranged in size from 15mm. to 47mm., a difference of 32mm., and the average length was computed to be 23.9mm. The greater number ranged about 20mm., but it would appear from the curve (fig. 2, plate XII.) that the smaller sizes were not fully represented.

In July the collections were made from the 10th to the 13th. The number of plaice taken was 448, ranging in size from 17mm. to 57mm., the average being 29.0mm., or only about 5mm. higher than in June. The interval may be placed at about 18 days.

The measurements of the plaice in these four series of collections, reduced to percentages, are as follows :—

Cm.	1903.		1901.	
	June.	July	July.	August.
1	—	—	·1	—
·5	13·3	·2	1·3	—
2	35·3	8·9	7·3	—
·5	25·7	32·8	30·2	—
3	17·8	37·1	29·3	—
·5	4·6	14·5	17·4	1·8
4	1·8	3·3	8·7	9·0
·5	1·4	1·8	3·6	12·6
5	—	1·1	1·7	20·1
·5	—	·2	·4	16·9
6	—	—	·03	13·1
·5	—	—	—	10·2
7	—	—	—	7·3
·5	—	—	—	4·7
8	—	—	—	2·5
·5	—	—	—	1·4
9	—	—	—	·18

The features are also shown in the curves. It is probable from an examination of the individual collections that the larger forms are not sufficiently represented. They no doubt move out into somewhat deeper water even at this early stage, and in part get beyond the depth at which a man wades in using the push-net at low tide.

#### ABERDEEN BAY.

A number of collections were made in Aberdeen Bay by means of a small fine-meshed shrimp net, used from a yawl, in depths usually ranging from 3 to 6 or 7 fathoms. The measurements of these are grouped in ·5 centimetres in Table IV., and it is apparent that, though the numbers of fish are in no case large, three annual series or generations are at least indicated. Thus, there is represented a series ranging from 2cm. to 9cm. or 10cm. or a little more; another from 15cm. or 16cm. to 24cm. or 25cm., and a third from about 27cm. to 34cm. These are best seen in the aggregates for March, April, and May, which, with those for September and November, as grouped in centimetres measure as follows :—

[TABLE.

Cm.	March.	April.	May.	September.	November.
1	-	-	-	-	-
2	-	-	2037	-	-
3	-	-	-	-	-
4	2	-	1	1	1
5	7	2	15	1	-
6	2	6	16	-	1
7	2	6	8	-	1
8	-	3	6	2	1
9	1	4	6	-	-
10	-	-	-	-	-
11	-	1	2	-	1
12	-	1	-	-	2
13	-	-	-	-	1
14	-	-	-	-	-
15	-	-	1	-	-
16	-	1	1	1	-
17	-	1	1	-	1
18	-	1	-	-	1
19	-	1	-	-	-
20	-	-	1	-	-
21	-	2	1	-	-
22	-	2	-	-	-
23	-	2	-	-	-
24	-	1	-	-	-
25	-	-	1	-	1
26	-	-	-	-	-
27	-	3	-	1	1
28	-	3	-	-	1
29	-	7	-	-	3
30	-	2	-	-	1
31	-	6	-	-	-
32	-	1	-	-	1
33	-	4	-	-	-
34	-	1	-	-	-
35	-	-	-	-	-

It is clear that the small plaice ranging from about 4cm. to 9cm. in spring belong to the previous year, and are one year old or a little more. The plaice of the year appear on the sands in May in great swarms. On 12th May, 1904, a collection of 717, measuring from 12mm. to 18mm., was taken on the sandy bottom in Aberdeen Bay in a fine-meshed net in hauls made in from 4 to 7 fathoms. On 18th May a collection of 1320 was taken in the same way in from 3 to 5 fathoms; they measured up to 19mm. and 20mm. In both cases several of the specimens were incompletely metamorphosed. Some of those caught on 12th May were kept alive in a tank, and on July 7—56 days afterwards—seven of them measured 26mm., 24mm., 24mm., 23mm., 21mm., 19mm., and 17mm.

From these records it appears that the first group in spring, the sizes of which range mostly about 5cm. to 7cm. or 8cm., is about one year of age; the second group, with a size mostly from 17cm. to possibly 22cm., represents two-year-olds; and the third group, ranging mostly about 29mm. to 32mm., is at least a year older. The numbers of fish are not large in any of these collections, and the precise limit between one series and another is uncertain. In a collection made on 9th May, 1902, in Aberdeen Bay, in from 4 to 10 fathoms, there were 126 plaice, of which the first series, over one year old, comprised 98 specimens, ranging in size from 57mm. to 126mm., the arithmetical average being 92·2mm., and the maximum ordinate on the base-line in the curve 92·5mm. The second series, which was imperfect, comprised 28 specimens from 140mm. to 227mm., the average of this lot being 190·8mm., and the maximum ordinate 185mm., or  $7\frac{1}{4}$  inches.\*

\* *Twentieth Annual Report, Part III., p. 353.*

## DORNOCH FIRTH.

In the Dornoch Firth some collections of small plaice were also obtained, the particulars of the measurements being given in Tables IV. and VI. On 7th December, 1904, a haul in from 4 to 9 fathoms yielded 182 plaice. The smallest ranged from 59mm. to 98mm.; there were 19 between these sizes. There were also 13 measuring from 125mm. to 145mm. The remainder measured from 173mm. to 472mm. The first group is evidently the fish of the year; the limits of the other series are not certain. On 9th February, 1905, another haul with the fine-meshed net, in from  $5\frac{1}{2}$  to 10 fathoms, yielded 355 plaice, ranging in length from 5cm. to 16cm., and distinguished into two well-marked groups. The first included 283 specimens, measuring from 52mm. to 99mm. ( $2\frac{1}{8}$ – $3\frac{7}{8}$  inches), or it might possibly be 108mm. ( $4\frac{1}{4}$  inches), the maximum number being around 7cm. (see fig. 4A, pl. XII.). The average length was computed, on the former limit, at 74mm., or very nearly 3 inches. If at the larger limit, the average size would be 74.5mm.

Grouped in centimetres, the measurements are as follows:—

5	6	7	8	9	10	11	12	13	14	15	16
8	59	115	78	19	6	7	14	21	19	8	1

The smaller series are obviously fish of the previous spawning, and about 10 or 11 months old.

In the second, older series, comprising 72 plaice nearing the end of their second year, the greater number are grouped about 13cm. to 14cm. ( $5\frac{1}{8}$ – $5\frac{1}{2}$  inches), the mean size being about 13.3cm., or  $5\frac{1}{4}$  inches, and the apparent growth from the previous series amounts to about 6.5cm. ( $2\frac{5}{8}$  inches); but the representation of the larger fishes may not be perfect.

In another haul on the 31st of March, or about 52 days later, but in a different year, viz., 1904, the second series is represented by 29 specimens, ranging from 112mm. to 196mm. ( $4\frac{3}{8}$ – $7\frac{3}{4}$  inches), as follows, in centimetre grouping, the mean size being about 14.5cm. ( $5\frac{3}{4}$  inches):—

9	10	11	12	13	14	15	16	17	18	19	20
1	—	1	1	7	3	6	8	1	1	1	—

These may be regarded as two years of age (fig. 4B, pl. XII.).

The same group is represented in other collections, as given in Table VI., but only by a few fishes, viz., in October, November, and December.

In a haul taken on the 22nd October, 1903, in from 8 to 13 fathoms of water, the 363 plaice which were caught were measured. Though the small-meshed net was employed, the smallest plaice caught was 164mm.; the great bulk of them formed a group between 20cm. and 29cm., with the maximum from 23cm. to 26cm. These fish were approaching their fourth year.

## ANNAN.

A few collections of small plaice in April, 1904, were sent to me by Mr. George Bryson, Annan, which had been taken by shrimp-net in the Solway, on the ordinary shrimping grounds. It will be seen from Table IV. that an early series of fish, about one year of age, is represented, most distinctly in the collection on the 23rd of the month, and also a second series, less distinctly marked off from the third, and again best shown in the collection on the 23rd. They indicate the same feature as shown in the previous paper dealing with the growth of the plaice, that the rate of increase in the Solway is slow.



## BURGHEAD BAY.

The plaice taken in several of the hauls in this locality were measured, and the measurements are given in Tables V., VI., at the end of this paper. On 20th October, 1903, a collection of 233 was taken in from 8 to 12 fathoms, the small-meshed net being around the cod-end. The smallest plaice caught was 175mm., and, with another specimen measuring 193mm., probably represented the second group. The next smallest was 216mm., and the bulk of the plaice came between this and 30cm., the majority measuring from 24cm. to 26cm., and representing the third series. The haul in the Dornoch Firth two days later, in which 363 plaice were taken, corresponded pretty closely, as above indicated.

At the beginning of December (6th and 7th), 1904, a considerable number of plaice taken in from  $4\frac{1}{2}$  to 16 fathoms, in BURGHEAD BAY, were measured, the sexes being first determined and dealt with separately. The number so treated in three hauls was 1737. These measurements are given in the appended Table V. The separation of the groups is not so well seen in these cases as one might expect. The great bulk of the fish measured between 25cm. and 42cm., and in the case of the females it was not difficult to see that they were separated into two groups, at 34cm. to 35cm. The curve formed by the measurements of the males is much less regular.

The plaice in some other ordinary hauls, taken in from 5 to 21 fathoms on 7th February, 1905, were kindly measured for me by Dr. Williamson, the sexes being distinguished, and also the condition of the reproductive organs (Table VII.). The range in size was from 20-68cm., but the separation of the groups is not very clear; females seem to show maxima about 30-31cm. and 34-35cm. The size at maturity, it will be observed, is about 41cm. for males and 42-43cm. for females; but the number of mature or nearly mature plaice was very small.

COMMON DAB (*Pleuronectes limanda*).

The number of common dabs whose measurements are dealt with here is 8094, belonging to 28 collections from the Moray Firth and Aberdeen Bay. With those included in the previous paper, the total number of common dabs, mostly measured on board commercial trawlers, is 26,230. In many of the recent collections the first, or youngest, series is specially well represented, and the facts show that this fish grows slowly.

## ABERDEEN BAY.

The collections of young dabs made here were taken in fine-meshed nets, mostly from a fishing yawl, in comparatively shallow water, the depths ranging as a rule from 3 to 6 or 7 fathoms. There are 11, viz., 1 in January, 1 in February, 1 in March, 3 in April, 2 in May, 1 in September, and 2 in November. In Table VIII. appended, the measurements of the fish in each collection are given in .5 centimetre groups. Few of them show well in any series but the first.

On the 3rd January, 1906, a collection of 323 was obtained in 8 fathoms of water. The smallest measured 27mm., or slightly over 1 inch, and the largest was 63mm., or  $2\frac{1}{2}$  inches; the majority ranged in size from 35mm. to 41mm. ( $1\frac{3}{8}$ - $1\frac{5}{8}$  inches), and the average size computed is 39.2mm., or slightly over  $1\frac{1}{2}$  inches.

The next collection, on 11th February, 1905, was taken in somewhat deeper water, viz., 8-12 fathoms, and comprised only 16 small dabs. The smallest measured 32mm., and the largest of the series 67mm., most ranging from 3.5cm. to 4.5cm.

[illegible]

In one or two of the collections a second group is fairly well indicated. Thus, in that of 26th April, we have a series extending from 112mm. to 164mm. ( $4\frac{3}{8}$ – $6\frac{1}{2}$  inches), most being aggregated at 12cm. to 14cm. This group is apparently approaching two years of age. Then, in the collection taken on 1st September, the second group begins at 89mm. and apparently ends at 153mm., and it represents fish at nearly the end of their second summer's growth. A comparison of the Tables and dates will show that the very small dabs grow slowly, and like the small plaice, grow very little in winter.

#### MORAY FIRTH.

In some collections from the Moray Firth the small dabs are also well shown (Tables IX–X.). On 9th February, of a collection got in the Dornoch Firth, in from  $6\frac{1}{2}$  to 10 fathoms of water, 377 ranged in size from 31mm. to 78mm., the greater number being aggregated from 4cm. to 5cm. These fish, of course, belonged to the spawning of the previous year, and were about nine months old. On the 7th December, in another collection from the Dornoch Firth, in from 4 to 9 fathoms, 219 specimens measured from 24mm. to 65mm. (the next largest being 92mm.); they were mostly aggregated from 32mm. to 42mm., and chiefly at 36mm., or barely  $1\frac{1}{2}$  inches. In a large collection made at Smith Bank on the 27th December, 1903, 66 small dabs measured from 25mm. to 72mm. (the next largest being 84mm.), and in this case the greater number were aggregated between 25mm. and 35mm.

In the Tables the measurements of a large number of older dabs are given, but the division between the annual series is not always very clear. In the Dornoch Firth, in the hauls in December, a group with the majority of the specimens aggregated between 10cm. and 12cm. (about  $4\frac{1}{2}$  inches) may be noted; while in the collections from Smith Bank in the same month the group has the aggregate between 10cm. and 14cm. In the haul from the Witch ground at the end of January the aggregate is at 14·5cm. to 15·5cm. ( $5\frac{3}{4}$ – $6\frac{1}{8}$  inches), and these fish are approaching their third year.

#### FLOUNDER (*Pleuronectes flesus*).

The information afforded by the collections as to the rate of growth of the flounder is rather scanty, small specimens of this species coming only rarely under observation in the course of the investigations. The young flounders prefer the shallows, especially at the mouths of streams, and where the water is brackish, and even the adult is uncommon in water of moderate depth, except at certain times of the year. The number measured was 231.

In the course of the push-nettings in Lochfyne specimens of flounders were occasionally secured, though usually in very small numbers. A series obtained on 5th July, 31 in all, measured from 16mm. to 53mm. ( $\frac{5}{8}$ – $2\frac{1}{8}$  inches), the greater part being grouped at 3cm., or scarcely  $1\frac{1}{4}$  inches, the arithmetical average being 31·9mm., or  $1\frac{3}{8}$  inches. This is rather more than with the little plaice collected at the same time, in which case the majority ranged from 24mm. to 32mm., and the computed average size was 30·3mm. The spawning period of the flounder in Lochfyne, according to Williamson, is a little later than that of the plaice.\* It is not unlikely that at this period the habitat of the young flounder leads to an exceptionally rapid growth, viz., in the very shallow and mostly brackish waters, where the temperature in the summer months is highest; and probably also its growth in winter is arrested.

\*Seventeenth Annual Report of the Fishery Board for Scotland, Part III.

Another collection, on 10th September, in Lochfyne, yielded 17 young flounders, the smallest measuring 44mm. and the largest 78mm. ( $1\frac{3}{4}$ – $3\frac{1}{8}$  inches). It is not clear, however, that the last, and another at 77mm., belong to the same series, since none were taken between 61mm. and the sizes stated. They were mostly aggregated about 5cm., or 2 inches. The other collections of little flounders were small, and serve to indicate only a few points. Thus, some taken in spring, and therefore not belonging to the year's spawning, were rather small in certain cases. On 27th March 2 were got in Lochfyne, measuring 63mm. and 99mm. On 25th May 2 were taken in the Dornoch Firth, one measuring 60mm. and the other 70mm. At Annan, in April, two, measuring 82mm. and 90mm. were taken. These represented fish of the preceding year, and there are few of the second series in the collections; but it is probable that while those mentioned, and a few others of the same kind in the Table, belong to the second group, or those a little over one year old, those in the Tables at 17cm. to 19.5cm. are at least a year older.

A large collection of flounders was obtained in the Dornoch Firth on the 30th March, 1904, in from 5 to 16 fathoms, in the otter trawl, and as they were either actually spawning or nearly ripe, the sexes were separated and measurements made. They numbered 158, namely, 136 males and 22 females, the males in this species preponderating in numbers over the females. It is unfortunate that the small-meshed net was not used on this occasion, but, at the same time, it is not probable that many more small flounders would have been taken, as the smaller fish do not migrate to the depths referred to. The smallest male flounder in the collection measured 20.2mm., or just 8 inches, and the smallest female was 25.2mm. The measurements are not sufficient to enable the fish to be separated into definite annual series with any certainty, but they in all probability represent flounders of at least three years and over.

#### LEMON DAB (*Pleuronectes microcephalus*).

The growth of the lemon dab has not been made out so well as that of most of the flat-fishes. This is owing to several circumstances. The spawning period is of exceptional length, extending from the middle of April to well on in September and even into October. Of a number of large lemon dabs examined at a fish-yard at Aberdeen on the 21st and 22nd September, all the males—129 in number—yielded more or less spermiatic fluid on pressure, and of 168 females, 44, or 26 per cent., contained ripe eggs, and were, in point of fact, spawning. On 10th November all were found to be spent. Eggs of the lemon dab were also obtained in tow-nets on 8th October. Owing to this circumstance of the extended spawning period, the various annual groups soon coalesce to such an extent as regards length that it is difficult to separate them. Another difficulty is the scarcity of small specimens. For a long time lemon dabs under three or four inches were unknown, though now specimens under that size have been recorded by Holt, Cunningham, and myself. Still another reason is the fact that large individual collections of lemon dabs are not very often obtained by the trawl. They are scattered, and it would appear that collections from different parts may show a different rate of growth. The number dealt with in this paper is 2201.

I ascertained that in the Solway the boats that carry on prawn-fishing by means of trawl nets often take considerable numbers of small lemon dabs, and I arranged for collections to be made from the boats and the fish forwarded to me. Such collections were obtained in April, May, and

September, and the measurements, in .5cm. groups, are given in Table XII. (p. 256). The fish are caught on rough ground off the Cumberland coast, in about 4 fathoms of water, and are rather localised in their distribution.

In dealing with them the sexes were first carefully determined, microscopical examination being resorted to when necessary; the proportions of the sexes in these collections were thus made precise and certain. Most of the series were also weighed and the condition of the reproductive organs made clear, and some remarks on this head may be of interest. In the collection in September it is noted that the females had small ovaries, weighing less than one gramme, and usually only a fifth or a tenth of a gramme. The eggs were small and unyolked, the largest measuring up to .106 and .134mm. In May the great majority had also small unyolked eggs, but some of them had large eggs and would have spawned in the ensuing summer. This was the case with one measuring 201mm., in which the eggs measured .72mm., and also in others from 164mm. to 188mm., where the eggs were of the same size. In one of 188mm., weighing 75 grammes, the roe weighed 5.9 grammes and the eggs were .73mm. in diameter. Another of 182mm. long weighed 66 grammes, the roe weighing 4.0 grammes, and the eggs were of the same diameter as those mentioned. I previously recorded instances of still smaller lemon dabs being quite mature.\*

These lemon dabs from the Solway Firth varied in length from 5.5cm. to 20cm., the smallest obtained was 57mm. (2½ inches) taken in April, and the largest was 202mm. (8 inches). The smallest were got in April (22nd), and the Table shows that in all probability a group terminates about 10cm. No males were got between 98mm. and 114mm., and no females between 89mm. and 111mm. Two females were taken at 57mm. and 59mm., the next being 80mm.; while the smallest male was 71mm. There is thus a suggestion that the two females represent the larger specimens of a younger group.

In the May collections three groups appear to be represented, when curves are drawn of the measurements; the first and third are only partly present, the bulk of the collection consisting of fish from 10cm. to 16cm. and aggregated around 13cm. and 14cm. (5½ inches). The figures for the totals for the 6th and 15th May, grouped into centimetres are as follows:—

8	9	10	11	12	13	14	15	16	17	18	19	20	21
2	7	3	13	16	21	23	12	8	20	9	2	2	-

The measurements of the separate collections similarly arranged are:—

	Cm.	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
April 22,	.	1	1	2	7	3	1	3	3	3	3	3	3	1	2	-	-	-
May 6,	.	-	-	-	1	3	1	8	11	15	19	12	8	14	11	4	2	-
„ 15,	.	-	-	-	-	9	1	3	4	6	5	3	3	5	1	-	-	-
„ 24,	.	-	-	-	1	2	-	1	1	-	1	1	1	4	-	-	-	-

Obviously none of the specimens belong to the year; the smallest must be approaching one year of age, or are over it.

In the collections made in September the extreme range of the sizes is very much the same, and the curve of the total shows that a division

\* *Twenty-first Annual Report of the Fishery Board for Scotland, Part III., p. 48.*

between two groups is about 13cm. to 14cm., the fish being aggregated at about 12cm. and 16cm. to 17cm. respectively. The figures of the total measurements arranged in centimetres are as follows:—

6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	3	10	9	22	49	64	50	51	67	62	62	27	9	2	-

The corresponding figures for the individual collections are:—

	Cm.	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Sept.	2	.	-	-	-	6	2	3	2	2	2	3	2	-	1	-	-
	„	9	.	-	-	1	3	4	21	32	19	14	21	23	29	4	1
	„	15	.	-	-	4	3	11	22	21	27	34	43	35	31	23	7
	„	25	.	1	3	5	3	1	4	8	2	1	1	1	-	-	-

Small lemon dabs, though not quite so small, were also obtained in various hauls in the Firth of Forth and in the Clyde, the particulars of the measurements of which, arranged in 5cm. groups, are given in Tables XIV., XV. In May, in the Forth, a collection of 68 ranged in length from 10cm. to 30cm., four groups being probably, but unequally, represented. In the most outstanding the majority of the fishes are grouped around 15cm. to 17cm., and they are thus a little larger than the corresponding May collection from the Solway, where, as was previously shown, plaice and dabs at all events grow more slowly than on the east coast. It would appear that these fish are entering their third year, the two-year-old fish being represented by the few of a smaller size. There is a second aggregation of lemon dabs between 23cm. and 30cm., but they not improbably represent at least two series. The figures, as arranged in centimetre groups, are these:—

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	1	1	1	6	8	11	2	1	1	1	2	1	2	6	4	4	4	6	4	1

A small collection was also obtained in August, but the number was scarcely sufficient to give a reliable clue to the growth. Arranged in centimetres, the measurements are these:—

9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	3	-	2	2	2	1	3	1	3	5	3	6	1	-	1	-	-	-	1

The collections in the Clyde (Table XV.) were obtained in somewhat deep water in the neighbourhood of Ailsa Craig. In September, those taken numbered 79, and a curve of the measurements shows them mainly aggregated between 12cm. and 18cm., with a deeply indented apex, the maxima being at 13cm. and 16cm., thus corresponding fairly closely to the collection from the Solway in the same month of the year. On the 5th October a number measured from 8cm. to 25cm., the mass being aggregated between 13cm. and 19cm., there also being an indentation in the curve at 15cm. The figures grouped in centimetres are these:—

8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	2	-	-	3	7	9	3	9	4	7	4	1	1	-	1	2	1	-	-

The collections from Aberdeen Bay were more numerous (Tables XIII., XIV). The largest was obtained on 21st August at the "Doghole," a

few miles off, in 58 fathoms of water, the specimens numbering 118. The measurements, arranged in centimetres, are as follows:—

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
2	3	2	2	2	1	1	6	7	5	10	13	3	3	5	4	6
27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
11	7	3	1	4	5	1	4	3	-	2	-	1	-	-	1	-

The curve shows at least five groups, though the lines are not very regular. The first comprises the fish up to about 15cm. The middle of the base is about 12cm. or 12.5cm. The next extends from 16cm. to 22cm. or 23cm., the maximum number are at 21cm., and the middle of the base about 19cm. to 20cm. The third extends from 22cm. or 23cm. to 30cm., the greater numbers are at 27cm., and the middle of the base is about 26cm. or 26.5cm.

In hauls in July, on the 31st and 30th, that is about three weeks earlier, the same order of grouping can be made out, the measurements being as follows:—

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	1	2	1	1	-	1	1	2	4	-	3	-	2	-	3	2	-
29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
6	4	7	6	3	5	4	3	5	7	5	4	6	4	1	2	-	1

In collections made in October, the first and second of the above indicated series are best shown. The following are the figures of the measurements, arranged in centimetres:—

	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
8th	.	-	-	3	-	3	-	-	1	1	1	-	1	-	-	-	1	-	-	-	-	1	-
23rd	.	-	-	4	2	1	3	3	1	-	5	1	2	3	-	3	-	-	-	-	-	-	2
31st	.	1	-	2	2	2	1	3	2	4	1	-	-	-	-	-	-	-	-	-	-	1	2

There are also given in Table XIII. the measurements from a large number of hauls taken in the Moray Firth and Aberdeen Bay on two occasions, the first from 8th to 13th October, 1900, and the second from 31st October to 9th November in the same year. The curve formed by the former series shows two great aggregations, the first extending from about 15cm. or 16cm. to 27cm. or 28cm., and the second from the latter point to 41cm. In the former the maximum number are aggregated at 23cm. (9 inches), and in the latter they are aggregated at 36cm. (14½ inches), a difference of 13cm., or a little over 5 inches. It seems tolerably certain, however, that one or other of these, and probably both, aggregations comprise more than one annual series, though the very deep depression between the two cones is marked, and very distinct. The measurements at the beginning of November are less satisfactory, the curve formed being irregular. The second aggregation is poorly represented, but the first is well marked, but begins at 14cm., and the maximum number are at 18cm.; there is a well-marked depression at 27cm., much as in the curve of the measurements taken some weeks earlier. The figures arranged in centimetres for the two series of measurements are as follows:—

	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
(1)	.	-	-	2	1	1	3	17	12	17	25	15	18	12	7	7	6	4	6	9
(2)	.	1	4	3	11	16	21	25	14	12	14	13	11	10	10	8	2	7	7	10
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46				
(1)	.	11	9	20	31	31	47	27	20	22	15	4	11	1	1	-	-			
(2)	.	2	3	2	2	2	7	4	1	1	2	-	1	1	1	-	-			

Larval and post-larval lemon dabs have been obtained at periods which correspond with the long spawning season. Thus, Cunningham records specimens of 10mm. and over taken in April, and specimens of this size are taken in May, while at the end of October they have been secured in considerable numbers measuring from 8mm. to 18mm. It is obvious that in the succeeding year, say in spring, the young lemon dabs derived from these would vary much in size. The early ones would have the full benefit of the favourable temperature throughout the whole year, while those of October would meet with the colder water in winter and have their growth retarded. Thus, a specimen caught by the "Garland" on 7th May, which measured 25mm., was no doubt derived from the preceding year, while specimens measuring 27mm. taken in August belonged to the same year.

Young lemon dabs in some number were got by Holt at the Humber in October and November, measuring from 2 to  $3\frac{1}{4}$  inches, which might possibly have been derived from the spawning of that year, but the larger, at least, were more probably from that of the year before.

Cunningham, at the beginning of June, took small lemon dabs on the Essex coast from 3 to 5 inches long, and these were clearly at least one year old.

The evidence seems to me to justify the belief that the growth of the lemon dab is slow, and probably does not much, if at all, exceed 5cm. to 6cm. (2 to  $2\frac{1}{2}$  inches) in a year. It is probable that the female does not spawn before the fourth year, though the prematurely mature specimens occasionally got\* probably spawn at an earlier age, and may form a distinct variety.

#### LONG ROUGH DAB (*Drepanopsetta platessoides*, Fabr.).

Various collections of long rough dabs were measured, the total number being 3529, part of them being from the Moray Firth and part from Aberdeen Bay (Table XVI.). Including those dealt with in the previous paper, the aggregate number measured amounts to 20,261.

Several of the collections contained the very small series which are always in this species well separated from the older series, contrasting with the case of the lemon dab. The spawning period of the long rough dab extends from the end of January well into May, and is chiefly marked at the end of March and the beginning of April. Each year's brood have therefore the summer following for growth, and not, as in the lemon dab, part of them the summer and part of them the winter.

In three collections made in the Moray Firth the early group is well shown. The first was taken on 28th December in 30 fathoms, on the so-called witch ground off Burghead; the second on 23rd January, but somewhat further east off Kinnaird Head, in 50 fathoms; and the third on 1st April, in the neighbourhood of the place where the first haul was made, in from 30 to 32 fathoms.

In the December collection 73 fish belonged to this group; they ranged in length from 46mm. to 65mm. ( $1\frac{1}{3}$ – $2\frac{1}{8}$  inches) (the next largest in the collection being 85mm.), and the average length was 56.8mm., or  $2\frac{1}{4}$  inches. In the January collection there were 57 specimens, ranging from 47mm. to 68mm. ( $1\frac{1}{2}$ – $2\frac{1}{4}$  inches) (the next largest being 86mm.), and the average computed size was 57.4mm., or  $2\frac{1}{4}$  inches. The third collection contained 84 specimens of the class, varying in length from 47mm. to 70mm. ( $1\frac{3}{4}$ – $2\frac{3}{4}$  inches), and the average was 56.2mm., or almost  $2\frac{1}{4}$  inches, the next largest in the collection being 89mm.

\* See *Twenty-first Annual Report*, Part III., p. 48.



	Number of Fish.	Range in Length.	Average Size.
28th December 1903 .	73	46-65mm.	56·8mm.
23rd January 1904 . .	57	47-68mm.	57·4mm.
1st April 1904 . . . .	84	47-70mm.	56·2mm.

As already stated, the locality of the collections in December and April were the same, and the facts show how much retarded the growth of this fish may be during winter.

In previous collections, described in my paper in the *Twentieth Annual Report*, numbers of these small long rough dabs were secured, and the average length in some cases may be referred to. The facts show that the growth of this somewhat deep-water fish does not materially differ in the north-eastern parts of the North Sea as compared with the Moray Firth. In the deep water off the Shetlands, on 31st August and 4th September, the average size was 48·3mm. and 48·4mm. On 16th-19th October it was 53·3mm.; on 11th December it was 54·4mm., and on 19th May 68·4mm. Off Aberdeen Bay, on 21st August, 11 specimens had an average length of 53mm.; on 16th December the average length of 116 specimens was 65·5mm. On 4th July, in from 83-85 fathoms, off Kinnaird Head, 146 had an average length of 98·3mm. ( $3\frac{7}{8}$  inches). It is thus clear that the growth of this fish, as formerly remarked, is slow, and that when one year old its average length does not greatly exceed two inches.

In some of the collections the older groups are well indicated. In that of 28th December, off Burghead, the sexes were not completely separated, but in the lot of 23rd January they were. The females in the second series in this collection range in length from 92mm. to about 129mm. ( $3\frac{5}{8}$ - $5\frac{1}{8}$  inches), the average being about 112mm., or 11cm. ( $4\frac{1}{2}$  inches). The males vary in size from 89mm. to 118mm. or thereabout, and the average size is a little over 10cm. (or 4 inches). The increase in length from the previous annual series is thus about 5·5cm., or  $2\frac{1}{4}$  inches; in other words, the females at this stage grow about that more in the course of a year. The difference in the case of the males is less, viz., from 57mm. to about 103mm., or 4·5cm., a little over  $1\frac{3}{4}$  inches.

The curve in this case shows a somewhat more rapid growth of the females than the males, the latter lagging behind, and the fact suggests that the males are approaching reproductive activity. I have shown before that males may be sexually mature when scarcely 5 inches (127mm.) long, and may show testes half developed when only  $3\frac{1}{2}$  inches (89mm.) long. The date of this collection about coincides with the beginning of the spawning season, and is more than three months distant from its close, and thus probably some of the males would reach reproductive length during the spawning season. It is much more likely that the third series represented in the collection is the chief reproductive series. In it the males extend in length from 11·5cm. ( $4\frac{1}{2}$  inches) to 16cm. or over ( $6\frac{1}{2}$  inches), the average size being about 13·5cm. ( $5\frac{1}{4}$  inches). This group is very nearly three years of age.

The females in the third series are widely separated from the second, so that, in the curve, the curve of measurements of the males of the third series is intercalated in the gap between the curve for the second and third series of females—a usual circumstance among flatfishes at the

period when maturity is reached. The third series of females, which comprises the greater number of fishes, begins about 12.5cm. and appears to extend to 20cm. The cone in the curve is a wide one, and the apex, or point where the fish are chiefly aggregated, is at 16.5cm. (6½ inches).

The results may be stated in tabular form as follows :—

Group.	Sex.	Probable Age.	Range in Size.	Average Size.	Apparent Growth in Year.
I.	—	10 months.	47-68mm.	57.4mm.	57mm.
II. {	♀	1 year and 10 months.	9-13cm.	11cm.	5.5cm.
	♂	" "	9-12cm.	10cm.	4.5cm.
III. {	♀	2 years and 10 months.	12.5-20cm.	16.5cm.	5.5cm.
	♂	" "	11.5-16cm.	13.5cm.	3.5cm.

In the collection obtained on 1st April the sexes were also separated and measured in the older groups. In the second series, or those about two years old, the females extended in length from 89mm. to 126mm. (3½-4½ inches), the average being about 10.5cm., or 4½ inches. This shows a rate of growth of about 5cm. (2 inches) from the previous year's fish. The males extended from about 9cm. to 11cm., (3½-4½ inches), the average length being about 10cm., or a little less, indicating a growth from the previous year's series of about 4.5cm. (1¾ inches).

In the third group represented the females extend from 131mm. to apparently 210mm. (5½-8½ inches), the fish being mostly aggregated between 15cm. and 17cm., the apex of the curve being at 17cm. If the latter be taken as the mean size of the group, the growth from the previous series would be on the average about 6.5cm., or 2½ inches, which is too large for this series. The presence of a small cusp at 15cm. leads one to suspect that this group is made up of two series.

The males of the third series are not numerous, and their size extends from about 11cm. to 15cm., the average length being approximately 13cm., or 5½ inches; the amount of growth indicated in the year from the previous series being 3cm., or barely an inch and a quarter. In tabular form the particulars are these :—

Group.	Sex.	Probable Age.	Range in Size.	Average Size.	Apparent Growth in Year.
I.	—	1 year.	47-70mm.	56.2mm.	5.5cm.
II. {	♀	2 years.	9-13cm.	10.5cm.	5.0cm.
	♂	"	9-11cm.	10cm.	4.5cm.
III. {	♀	3 years.	(13-21cm.)	(17)	(6.5cm.)
	♂	"	11-15cm.	13	3cm.

Of the other collections whose measurements are given in the Tables, it may be said that in that taken on 13th May at the "Doghole," off Aberdeen, in 55 fathoms, in which case the sexes were separately dealt with, the younger series is imperfectly represented. A group beginning as to the females about 12cm. or 13cm. shows an aggregation at 14cm. and 14.5cm., the apex in the curve of the measurements being at 14.5cm., after which there is a drop to 15.5cm. and a subsequent rise, indicating that the third series in the collection of 1st April contains two series. This is rather confirmed by the position of the aggregation of the males, the apex of the curve being in the gap between, viz., at 15.5cm. The numbers, however, are not very large.

### TURBOT (*Rhombus (Bothus) maximus*).

Observations as to the rate of growth of this important flat-fish leave much to be desired. The number measured by me, the measurements of which are given in Table XVII., was 212, but comparatively few of these refer to young fishes.

The spawning period is in summer, from about the middle of April to the early part of August, and is at its height in June. The larval turbot measures 2.2mm. to 2.8mm.; after the absorption of the yolk, in about a week, it measures 3.2mm. to 4.8mm., and metamorphosis is usually completed at about 27mm.\*

The pelagic metamorphosing forms are got in August and September, and partly in July, and the young forms on the sands in September and later. Thus Cunningham notes the pelagic forms from early in August till 8th September, measuring from 15mm. to 37mm., and which he thought were about one month old, but are probably older.

M<sup>c</sup>Intosh refers to specimens of 21mm. to 28mm. in July and August, and of 41mm. to 62mm. on 7th September; on 18th September, three, respectively, 44mm., 48mm., and 55mm., were got by me at the mouth of the Dou. M<sup>c</sup>Intosh records them 3 inches long (about 7.5cm.) in the middle of December, and this is the largest for the year of which I have noted a definite record.

From this time on to about the end of March it is almost certain the turbot grows little or not at all, as with other small flat-fishes in the same habitat.

In the spring of the next year the recorded sizes are as follows:—23rd May, 2 $\frac{3}{8}$  inches (60mm.), by M<sup>c</sup>Intosh; April 25th, 79mm.; May 16th, three at 68mm., 73mm., and 85mm., by Cunningham, who also says that from April to June, at Cleethorpes, they measure from 75mm. to 105mm. (3–4 $\frac{1}{8}$  inches). I received one from the Solway Firth, taken on 23rd April, which measured 95mm., while another from the same locality, caught on 27th November, was 119mm. (4 $\frac{3}{4}$  inches), and had no doubt passed through the second summer of its life.

The young turbot at or approaching one year of age is thus a very little fish, and probably ranges in size from about 70mm. (2 $\frac{3}{4}$  inches) or less to about 105mm. (4 $\frac{1}{8}$  inches).

A tank experiment of Cunningham's may be mentioned. In June he put into a tank a number of young turbot in the pelagic transforming stage; on the 19th October three, whose measurements are given, were 65mm., 95mm., and 99mm. respectively; on 4th April, in the next year, the one which survived was 108mm.

\* Ehrenbaum, Nordisches Plankton, Vierte Lieferung, I. Eier und Larven von Fischen. Theil I., p. 199, Kiel und Leipzig, 1905.

I append a Table showing the occurrence of the small turbot in the various months of the year. The bracket shows the spawning period.

Cm.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	-	-	-	-	-	-	-	-	-	-	-	-
.5	-	-	-	-	-	-	X	X	-	-	-	-
2	-	-	-	-	-	-	-	X	X	-	-	-
.5	-	-	-	-	-	-	-	X	X	-	-	-
3	-	-	-	-	-	-	-	X	X	-	-	-
.5	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	X	-	-	-
.5	-	-	-	-	-	-	-	-	XX	-	-	-
5	-	-	-	-	-	-	-	-	XX	B	-	-
.5	-	-	-	-	-	-	-	-	XX	-	-	-
6	-	-	-	-	X	-	-	-	XX	-	-	-
.5	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-
.5	-	-	-	B	B	B	-	-	-	-	-	X
8	-	-	-	B	B	B	-	-	-	-	-	-
.5	-	-	-	B	B	B	-	-	-	-	-	-
9	-	-	-	B	B	B	-	-	-	-	-	-
.5	-	-	-	XB	B	B	-	-	-	-	-	-
10	-	-	-	B	xxx	B	-	-	-	-	-	-
.5	-	-	-	B	B	B	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
.5	-	-	-	-	xxx	x	-	-	-	-	-	-
12	-	-	-	-	x	x	-	-	-	-	X	-
.5	-	B	B	B	xxx	x	-	-	-	-	-	-
13	-	B	B	B	xxx	x	-	-	-	-	-	-
.5	-	B	B	B	-	-	-	-	-	-	-	-
14	-	B	B	XB	xxx	xx	-	-	-	-	-	-
.5	-	XB	B	B	xx	-	-	-	-	-	-	-
15	-	B	B	B	xxxx	-	x	-	-	-	-	-
.5	-	-	-	-	xxx	x	-	-	-	-	-	-
16	-	-	-	-	x	xx	-	-	-	-	-	-
.5	-	-	-	-	-	xx	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-
.5	-	-	-	-	-	x	-	-	-	-	-	-
18	-	-	-	-	-	xx	-	-	-	-	-	-
.5	-	-	-	-	-	-	x	-	-	-	-	-
19	-	-	-	-	xx	-	xx	-	-	-	-	-
.5	-	-	-	-	-	x	-	-	-	-	-	-
20	-	-	-	-	xx	x	x	-	-	-	-	-
.5	-	-	-	-	-	x	-	-	-	-	-	-

In the salmon stake-nets at Montrose 52 young turbot were taken in May, June, and July, the measurements of which are given in inches in the Table subjoined (2), and as near as possible in centimetres in Table XVII.

The greater number were obtained in May, viz., 30, while 17 were got in June and 5 in July; perhaps an indication that the young turbot move further out with the rise in temperature.

From what has been stated above, it is probable that the smallest at 4 inches (101mm.) are turbot of the preceding year and are approaching their first year of age. Whether those at  $4\frac{1}{2}$  to  $4\frac{3}{4}$  inches (115mm. to 120mm.) in May are also fish of the preceding year, under one year of age, is not so clear. The curve formed by the May measurements appears to show the presence of four groups, and the first is separated from the second by a deep division at 13cm ( $5\frac{1}{8}$  inches), and the second from the third at 17cm. to 18cm. (7 inches) The figures, in centimetres, are as follows:—

10	11	12	13	14	15	16	17	19	20	21	22	23	24	25	26	27	28
8	8	6	1	5	7	1	-	2	2	-	-	2	-	1	-	1	-

It does not appear to me altogether probable, judging from the facts given above, and those that follow from the older groups, that all the turbot up to 13cm. ( $5\frac{1}{8}$  inches) are under one year of age. It will be observed that the young turbot are rather smaller than the young brill, and it must be borne in mind that the addition of a unit of length to a turbot means a much greater increase in growth than to any other fiat fish, owing to its breadth and thickness and its consequent greater proportional weight.\*

If regarded provisionally as approaching their second year, then the next group, from 13cm. to 17cm. or 18cm. ( $5\frac{1}{8}$  to 7 inches), must be looked upon as nearing their third year; the fourth group, from 17cm. or 18cm. to 22cm. (7 to  $8\frac{3}{4}$  inches), as nearing their fourth year; and those from 22cm. to 26cm. ( $8\frac{3}{4}$  to  $10\frac{1}{4}$  inches) as approaching their fifth year.

TABLE 2.

Inches.	May.	June.	July.
4	3	-	-
$4\frac{1}{8}$	-	-	-
$4\frac{1}{4}$	3	1	-
$4\frac{3}{8}$	1	1	-
5	5	2	-
$5\frac{1}{8}$	1	-	-
$5\frac{1}{4}$	3	2	-
$5\frac{3}{8}$	2	-	-
6	7	-	1
$6\frac{1}{8}$	1	1	-
$6\frac{1}{4}$	-	4	-
$6\frac{3}{8}$	-	-	-
7	-	3	-
$7\frac{1}{8}$	-	-	1
$7\frac{1}{4}$	2	-	2
$7\frac{3}{8}$	-	1	-
8	2	2	1
$8\frac{1}{8}$	-	-	-
$8\frac{1}{4}$	-	-	-
$8\frac{3}{8}$	-	-	-
9	1	-	-
$9\frac{1}{8}$	1	-	-
$9\frac{1}{4}$	-	-	-
$9\frac{3}{8}$	-	-	-
10	1	-	-
$10\frac{1}{8}$	-	-	-
$10\frac{1}{4}$	-	-	-
$10\frac{3}{8}$	-	-	-
11	1	-	-
$11\frac{1}{8}$	-	-	-

The possibility of each of these groups being a year younger must not be lost sight of; in any event, those of the latter size can scarcely be less than four years of age or near it.

Turning now to the collections which contain the larger fishes, we have some in October, November, December, and February, which are of interest. The measurements are given in Table XVII.

Although the numbers are not large in any instance, the arrangement and order of the figures are such as to lead to the supposition that the groups are of small dimensions.

The group above referred to, from the stake-nets, as extending from about 22cm. to 26cm., is represented by only a single specimen, at 23cm., taken in December at Burghhead Bay. It is at the end of either its fourth or fifth summer.

\*See *Twenty-second Annual Report*, Part III., pp. 144, 216.

The next series is represented in a collection from Aberdeen Bay in October, and in it there are ten turbot from 27·5cm. to 30cm. ( $10\frac{1}{2}$ – $11\frac{1}{2}$  inches), which are a year older.

The other series are shown in the Moray Firth collections in November, December, and February, the sizes ranging from 33cm. to 80cm. From Table XVII. it will be seen that a division appears to exist at 34–35cm., and it is probable that this group extends back at least to 30·5cm., as indicated in the October series.

The arrangement of the measurements in one-centimetre groups may be shown in the subjoined Table, in which column 4 summarises the figures for the three months, October, November, and December, and column 6 summarises them all:—

Cm.	1	2	3	4	5	6
	Oct.	Nov.	Dec.	Sum. of 1, 2, 3.	Feb.	Sum. of 1-5.
23	—	—	1	1	—	1
24	—	—	—	—	—	—
25	—	—	—	—	—	—
26	—	—	—	—	—	—
27	2	—	—	2	—	2
28	2	—	—	2	—	2
29	4	—	—	4	—	4
30	2	—	—	2	—	2
31	1	—	—	1	—	1
32	—	—	—	—	—	—
33	—	2	2	4	—	4
34	—	2	1	3	—	3
35	—	1	—	1	—	1
36	—	5	5	10	—	10
37	—	5	2	7	2	9
38	—	5	3	8	1	9
39	—	4	—	4	2	6
40	—	2	—	2	2	4
41	—	1	1	2	2	4
42	—	—	—	—	2	2
43	—	2	—	2	—	2
44	—	4	2	6	—	6
45	—	4	3	7	4	11
46	—	—	—	—	2	2
47	—	1	—	1	1	2
48	—	1	—	1	—	1
49	—	2	—	2	—	2
50	—	1	—	1	2	3
51	—	—	—	—	—	—
52	—	—	1	1	—	1

There appears to be evidence in this Table of the existence of at least five groups, and possibly six, if those turbot under 34cm. in November and December are regarded as separate from the October group. The points of probable separation of the groups, as shown in the 5cm. grouping, are 34·35·5cm., 46cm., and 50cm., or 52cm.

The age of these turbot is considerable in any way the figures may be regarded. It is possible that they represent fish of  $4\frac{1}{2}$ ,  $5\frac{1}{2}$ ,  $6\frac{1}{2}$ ,  $7\frac{1}{2}$ ,  $8\frac{1}{2}$ , and  $9\frac{1}{2}$  years of age; but they may be a year less, and, if the October group is looked upon as terminating at about 34cm. in November and December, the fishes above that size may be a year less still.

It, however, seems certain that turbot ranging from 35cm. to 41cm.

(13½-16½ inches) are not under 5½ years old, and that those about 50cm. (20 inches) are not under 7½ years of age, while those between 40cm. and 46cm. (16-18 inches), when reproduction is supposed to commence, are at least 6½ years old at the season of the year referred to, and may be a year, or possibly two years, older still.

It seems to me probable that the turbot does not spawn until it is at least seven years of age.

With reference to the slow rate of increase in length of the turbot, as thus indicated, the relatively great increment in weight must not be lost sight of. Thus a turbot of 44cm. (17¼ inches) weighs about 1830 grammes, and one of 50cm. (19¾ inches) weighs about 2700 grammes, while plaice of the same lengths weigh just about half—viz., about 950 and 1430 grammes respectively—and a female plaice of 44cm. is at least five years of age, and may be six. On the other hand, one would expect that the rate of increase of weight in the turbot would be greater than in the plaice, owing to its piscivorous habit and feeding.

#### BRILL (*Rhombus levis*).

As with the turbot, so with this fish, the observations in respect to the rate of growth are not as complete as they might be. A considerable number of specimens were, however, measured, viz., 1182, and they appear to be satisfactory as regards certain groups (Table XVIII.).

The spawning period of the brill is about a month or so earlier than that of the turbot, extending from the end of March into July, the chief spawning taking place in May. The egg is larger than that of the turbot, varying according to Heincke and Ehrenbaum, from 1.24mm. to 1.46mm., and hatching occurs in twelve or thirteen days.

The smallest specimens in my collections were procured from Aberdeen Bay on 18th September, being taken on the beach at low tide by means of a push-net; they numbered six, and measured as follows:—38mm., 40mm., 47mm., 49mm., 51mm., and 54mm., or 1½ to 2½ inches. At the mouth of the Forth, on the 17th September, four specimens measuring 41mm., 54mm., 57mm., and 58mm., and another of 78mm., or a trifle over three inches, were obtained in another year. Other small specimens taken were as follows:—One at 41mm. (1½ inches), by the push-net in Lochfyne on 27th July; one measuring 51mm., on 27th July, by shrimp-net at Annan, and another in the same locality on 30th April which measured 80mm. (3½ inches). M'Intosh mentions specimens measuring from 22mm. to 29mm. in August, one of 24mm. on 25th July, and others from 50mm.-61mm. in September. Cunningham records 34 specimens measuring from 22mm. to 25mm., between 21st May and 11th June.

All the above, with the exception of the specimen taken in the Solway, measuring 82mm. (3¼ inches), on 30th April, were no doubt derived from the spawning in the same year.

Other specimens which have been described, and which apparently belong to the spawning of the previous year, are as follows:—That referred to above, which was 82mm. long, on 30th April; one of 74mm. (2½ inches) taken on 4th May; one of 91mm. and another of 96mm. (3½ inches) taken on 25th April; one of 104mm. taken on 28th April; two on 15th June, measuring 89mm. and 104mm.; and two on 14th May, measuring 98mm. and 108mm. (4¼ inches)—all of which are referred to by Cunningham. These specimens, together with some of the smaller individuals got in salmon stake-nets and referred to below, may be included in the following Table; the latter are represented by a small (x), the former by a large (X):—

Cm.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	-	-	-	-	-	-	-	-	-	-	-	-
.5	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	XXXXXX	-	-	XX	-	-	-	-
.5	-	-	-	-	XXXXXX	-	X	-	-	-	-	-
3	-	-	-	-	-	x	-	X	-	-	-	-
.5	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	X	-	X X X	-	-	-
.5	-	-	-	-	-	-	-	-	X	-	-	-
5	-	-	-	-	-	-	X	-	XXX	-	-	-
.5	-	-	-	-	-	-	-	-	XXX	-	-	-
6	-	-	-	-	-	-	-	-	XX	-	-	-
.5	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-
.5	-	-	-	-	X	-	-	-	-	-	-	-
8	-	-	-	X	-	-	-	-	X	-	-	-
.5	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	X	-	X	-	-	-	-	-	-
.5	-	-	-	X	X	-	-	-	-	-	-	-
10	-	-	-	-	-	X xx	-	-	-	-	-	-
.5	-	-	-	X	-	X	-	-	-	-	-	-
11	-	-	-	-	X x	-	-	-	-	-	-	-
.5	-	-	-	-	x	xx	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-
.5	-	-	-	-	Xxxx	x	x	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-
.5	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	x	x	X	-	-	-	-	-
.5	-	-	-	-	-	x	-	-	-	-	-	-
15	-	-	-	-	xxxx	xxxx	x	-	-	-	-	-
.5	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	x	x	-	-	-	-	-	-
.5	-	-	-	-	x	x	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-
.5	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	x	x	-	-	-	-	-	-
.5	-	-	-	-	-	-	-	-	x	-	-	-

The outstanding feature of the above Table is that a line drawn diagonally from the top left-hand corner (at January) to the bottom right-hand corner divides the small brill into two groups, an upper and a lower; and the inference is that those below the line in April, May, and June are a full year or more in age.

Before considering this Table further, reference may be made to some experiments by Cunningham in rearing young brill in tanks. He placed the 34 specimens, measuring from 22mm. to 25mm., taken between 21st May and 11th June, and above mentioned, in an aquarium. He computed their age to be about three weeks or a month. On 18th October following four of them were measured, and their length was found to be from 70mm. to 98mm. ( $2\frac{3}{4}$ - $3\frac{7}{8}$  inches), the growth of these four, in the 140 days or so that elapsed, amounting to about 60mm.—or, to give the extremes, to from 45mm. to 76mm. The author does not state anything as to the sizes of the others, except that on 4th October one measured 85mm.; nor is the temperature given, but it is obvious that the period comprised the chief season of growth. Other two of these brill were measured on 3rd April in the following year, and their lengths were respectively 84mm. and 88mm. ( $3\frac{1}{4}$ - $3\frac{1}{2}$  inches), giving an approximate increase from the beginning of June in the previous year, or in about 307 days, of only 6cm., or  $2\frac{3}{8}$  inches. These fish were nearly one year old.

Cunningham suggests as a reason for the slow growth, which he thinks had been abnormally checked, that they were fed on marine worms and not on living fish; but it is much more likely that it was chiefly owing to the lowered temperature of the water in winter. I have already shown that small plaice at the same stage, which frequent the same habitat on



the beach, do not grow between October and April,\* and that this is true also of larger plaice kept in tanks and supplied with water from the beach.

It is probable that the young brill, living on the margin of the sea, does not increase in length from November till the latter part of March.

In a subsequent year Cunningham records having placed some young brill in the pelagic transformation stage in tanks in June. On 19th October following three measured 80mm., 85mm., and 104mm., and on 4th April in the next year one was 113mm.†

Looking to the Table above given, it will be seen that under natural conditions the young brill in September may reach a length of 6cm. and even 8cm., while those taken in April of the following year may measure from 80mm. to 105mm.; in May they may be as small as 74mm., 96mm., and 98mm., and in June as small as 89mm., that is, when fully one year old.

Some years ago a record was kept at Montrose of small brill and turbot taken in May, June, and July in stake-nets, as previously mentioned. They were measured to fractions of an inch. The total number of brill was 53, and 30 of them were taken in May, 16 in June, and 7 in July. The particulars are set forth in the appended Table.

Inches.	May.	June.	July.
1	-	-	-
$\frac{1}{2}$	-	1	-
$\frac{3}{4}$	-	-	-
2	-	-	-
$\frac{1}{2}$	-	-	-
$\frac{3}{4}$	-	-	-
3	-	-	-
$\frac{1}{2}$	-	-	-
$\frac{3}{4}$	-	-	-
4	2	-	-
$\frac{1}{2}$	-	-	-
$\frac{3}{4}$	2	2	-
5	-	-	-
$\frac{1}{2}$	4	1	1
$\frac{3}{4}$	-	-	-
6	2	1	-
$\frac{1}{2}$	-	1	-
$\frac{3}{4}$	6	4	1
7	-	1	-
$\frac{1}{2}$	2	-	-
$\frac{3}{4}$	-	-	-
8	1	-	3
$\frac{1}{2}$	-	-	1
$\frac{3}{4}$	-	-	-
9	1	-	-
$\frac{1}{2}$	2	2	-
$\frac{3}{4}$	2	-	-
10	2	1	1
$\frac{1}{2}$	-	-	-
$\frac{3}{4}$	-	-	-
11	-	-	-
$\frac{1}{2}$	1	-	-
$\frac{3}{4}$	-	-	-

\* *Twentieth Annual Report*, Part III., p. 342.

† *Jour. M.B.A.*, II., p. 106; III., p. 272.

The smallest one was got on 19th June in St. Cyrus Bay ; it measured  $1\frac{1}{4}$  inches, or about 3cm., and belonged no doubt to the brood of the year. The next smallest were 4 inches, or about 10cm., and brill of this size were procured on 8th and 12th May, and doubtless represent the fish of the previous year, and would therefore be about one year old. At  $4\frac{1}{2}$  inches (114mm.) four were taken, two on 4th and 5th May, and two on 5th and 6th June. The next size was five inches (127mm.), of which six were taken—four in May, one in June, and one in July (8th). At 6 inches (152mm.) there were eleven, six of which were obtained in May, four in June, and one in July. The largest brill secured was  $11\frac{1}{4}$  inches, in May.

Looking down the column for May, the place where the first striking interval occurs is between 8 inches and  $8\frac{3}{4}$  inches, or about 20cm. to 22cm. ; but it is pretty certain that fish of this length, or even of  $7\frac{3}{4}$  inches (19·5cm.) do not belong to the same series, which, as we saw, has individuals measuring as low as 74mm. in May.

The nature of the net by which the brill were taken must be borne in mind, practically all the very small fish and many of those of the sizes included in the Table no doubt escaping. It seems to me, considering the Table, the rate of growth of other flat-fishes, the much greater increase in weight or volume in the case of the brill than with the plaice, dab, &c., that the one-year-old group is represented in May by those at 4 inches (10·2cm.) and probably at  $4\frac{1}{2}$  inches (11·5cm.) ; that those from 5 to 7 inches (12·7cm. to 17·8cm.), or perhaps to  $7\frac{1}{2}$  inches (19·0cm.) are two years of age ; those from 8 to  $9\frac{1}{2}$  inches (20cm. to 24cm.)—and the group is obviously only partially present—are three years of age ; while the brill at  $11\frac{1}{4}$  inches (28·5cm.) is probably four years old.

It seems to me likely that the range of size of the one-year-old brill is from about 70mm. to about 115mm. ( $2\frac{3}{4}$  to  $4\frac{1}{4}$  inches), or perhaps a little less, with an average size of about 90mm. to 95mm. ( $3\frac{1}{2}$  to  $3\frac{3}{4}$  inches).

Attention may now be given to the catches made on board trawlers in the Moray Firth, the particulars in regard to which are given in Table XVIII. These hauls were limited to November, December, and February, and the collection in the latter month was a small one. In none of the cases were the sexes separated, the fish being too valuable to be opened for the purpose, and the collections under the various dates represent a series of hauls, all the brill taken having been measured. Some groups come out with distinctness, and the measurements may be grouped here in centimetres.

Cm.	NOVEMBER.			DECEMBER.			All November Hauls.	All December Hauls.	Both Combined.	Burghead, 6th, 7th February.
	Dornoch, 9th-11th.	Burghead, 9th, 10th.	Combined.	Burghead, 26th, 26th.	Dornoch, 25th, 26th.	Combined.				
21	-	-	-	-	-	-	1	2	3	-
22	-	-	-	-	-	-	1	2	3	1
23	2	-	2	-	-	-	4	4	8	1
24	-	-	-	-	-	-	1	-	1	-
25	1	-	-	-	-	-	2	-	2	1
26	1	1	2	1	-	1	3	2	5	-
27	2	2	4	-	2	2	5	3	8	-
28	-	6	6	1	3	4	8	6	14	1
29	-	7	7	1	2	3	8	5	13	1
30	2	6	8	2	4	6	9	9	18	1
31	2	11	13	1	7	8	16	9	25	3
32	2	10	12	1	8	9	16	12	28	5
33	3	4	7	3	4	7	7	8	15	1
34	2	1	3	1	2	3	5	6	11	-
35	1	1	2	1	1	2	7	6	13	2
36	4	7	11	-	2	2	23	8	31	2
37	4	4	8	-	1	1	37	16	53	10
38	3	4	7	-	1	1	39	18	57	25
39	2	6	8	-	1	1	35	25	60	22
40	3	4	7	1	-	1	36	23	59	24
41	-	3	3	1	1	2	25	16	41	27
42	-	4	4	2	1	3	11	11	22	14
43	3	3	6	1	1	2	12	8	20	13
44	-	-	-	-	1	1	4	7	11	6
45	-	-	-	1	-	1	3	3	6	4
46	-	-	-	-	2	2	5	4	9	-
47	-	1	1	-	-	-	2	3	5	2
48	-	-	-	-	1	1	1	2	3	1
49	1	-	1	-	1	1	5	1	6	-
50	-	-	-	2	-	2	1	2	3	2
51	-	-	-	-	-	-	-	1	1	-
52	-	-	-	-	1	1	-	-	-	-
53	-	-	-	-	-	-	1	-	1	1
54	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	-	-
56	-	-	-	-	-	-	-	-	-	1
57	-	-	-	-	-	-	-	-	-	-
58	-	-	-	-	-	-	-	-	-	-
59	-	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	1	-	1	-
61	-	-	-	-	-	-	-	-	-	-
62	-	-	-	-	-	-	1	-	1	-

The curves formed by these figures combined indicate a great group, which includes the greater proportion of the brill between about 34cm. (13½ inches), where a division between groups is most distinct, and 42cm. or 43cm. (17 inches). Taking the larger combined series first, for all hauls in November and December, the group extends from 34cm. to 45cm., but the lower part of the descending line of the curve and its form indicate the probability that two groups are combined, the probable division being at 41cm. to 42cm. The great majority of the fishes are aggregated at 37cm. to 40cm., the largest number being at 39cm. and the next at 40cm. (15½-15¾ inches).

In the November series the curve and its limits are much the same, the group beginning at 34cm., and it appears to terminate at 44cm. or 45cm.,

but more probably at 42cm. The fish are aggregated between the same limits, 37cm.-40cm., but the greatest number is at 38cm. (15 inches).

In the December series the lower limit is at 34·5cm.; the greater number of the fishes are at 39cm. and 40cm., most being at 39cm.; but the end of the group is not clear, the line falling gradually from 42cm. to 49cm.

The curve for the measurements of brill taken on 9th-11th November shows plainly a group beginning about 35cm., but the greater numbers of fish are at 36cm., after which the line of the curve falls more or less regularly to 41cm., then rising to 43cm., and falling thereafter; there are none between 43cm. and 47cm., but the numbers are not large.

The fish taken in the Dornoch on 9th-11th November show a group beginning about 35cm., and there is a similar fall at 41cm. to 42cm., and a rise to 43cm. In the hauls on 25th and 26th December this fall at 41cm. is also present. The curve of the measurements of the brill taken at Burghead on 21st-27th November show the group beginning at 33·5cm. or 34cm. and ending at 42cm., but there is a depression at 39·5cm. to 40cm.; most of the fish are aggregated between 37·5cm. and 40·5cm. In the brill taken in the early part of February the limits of the great mass are from about 34cm. or 35cm. to 44cm. or 45cm., but there are depressions at 39·5cm. and 42cm.; the greater number of the fishes are aggregated between 38cm. and 41cm., mostly at the latter (16 inches).

Comparison of the upper part of the cone of the curves, that is to say, the "modal" sizes, or the sizes at which the brill are most numerous, in the different periods, is indicated in the following Table:—

	Greatest Number Between.	Maximum.	Mean.
Burghead, November 9, 10 .	36-39	36	37·5
" " 21-27 .	37-41	38	39
" December 6-12 .	37-41	39	38·5
February 6-7 .	38-41	41	39·5
All November . . .	37-40	38	38·5
All December . . .	37-41	39	39·5

The next smallest series of brill shown in these collections ends where the last one begins, about 34cm. to 35cm. In all cases the measurements and curves indicate that the smaller fishes in the group are not fully represented. The fish are aggregated in greatest numbers at 31cm. to 32cm., which is larger than it ought to be by the limits of the group. The distances from the actual apex in the curves of the two groups, or the sizes of greatest frequency, are as follows, in centimetres:—

	Smaller Group.	Larger Group.	Apparent Annual Growth
November . . . .	31·5	38	6·5 (2½ in.)
December . . . .	32	39	7 (2½ in.)
Together . . . .	32	39	7 (2½ in.)
Burghead, November 9, 10, .	31	36	5 (2 in.)

The smaller group is well represented in the collection of 21st-27th November, but it is poorly shown in most of the others. It is obvious that the amount of growth in a year, as indicated in this comparison, is small.

The third or smallest group represented has its upper limit, as stated, about 24cm. ( $9\frac{1}{2}$  inches), but the lower limit cannot be determined from these collections, the smallest specimens measuring only 21cm. (216mm.), or  $8\frac{1}{2}$  inches, but it may be inferred from the consideration of the brill in the other collections.

The principal reason of the unequal representation of the three groups above referred to in the collections from the Moray Firth is no doubt the depth of water in which the trawling was carried on,  $4\frac{1}{2}$  or 5 to 13 and more fathoms. The smaller brill frequent the shallower water, and thus the proportion taken of the larger members of the second series is greater than the proportion of the smaller members, while comparatively few of the third or smallest series were caught, and they were only the larger fishes of that series.

It appears to me that the size—or age-groups—of the brill in these collections may be represented as follows with approximate accuracy:—

	Inches.	Centimetres.
1 year old. . . . .	23-41	7.0-11.5
2 „ „ . . . . .	5-7 $\frac{1}{2}$	12-17.5, 18
3 „ „ . . . . .	8-10	19, 20-24
4 „ „ . . . . .	10-12	25-30
5 „ „ . . . . .	12-14	30-35
6 „ „ . . . . .	14-16	35-40
7 „ „ . . . . .	16-17 $\frac{1}{2}$	40-44

At the same time, it must be recollected that the sexes were not distinguished and separately measured, and, judging from the case in other flat-fishes, the growth of the males will be slower than that of the females after the size of maturity is reached, and it is thus possible that what appears to be an age-group after that size may only be a sex-group. But, from the remarkable agreement in the various collections, as shown by the aggregate or combined curves, and by the separate curves, as to the existence of a division between groups at 34cm. to 35cm., it is clear to me that this confusion does not exist below that point, but that the sexes so far grow equally; and, therefore, that sexual maturity is not reached either by males or females till a size above 34cm. to 35cm. ( $13\frac{1}{2}$  to  $13\frac{3}{4}$  inches), and that the great spawning group lies, in winter, between 35cm. and 41cm. or 42cm. (14 to 16, 17 inches), when they appear to be about six years old.

It may be added that the weight of a brill at a given length is much greater than with other flat-fishes, except the turbot.\* The weight of a plaice about 39cm. is approximately 650 grammes; that of a brill about the same size is approximately 950 grammes. Thus the amount of growth of the brill by the increase of, say, 1cm. in its length is much more than in the plaice with a similar increase.

#### COD (*Gadus callarias*).

The number of cod measured and dealt with in the present paper, and belonging to 50 separate collections, is 3813, which, with those treated of in the paper published previously, makes a total of this species of 7176, most of which belong to the two or three first generations.

The main points brought out in the paper referred to were that the young cod of the year were on an average in October, when about six or

\* See Tables in *Twenty-second Annual Report*, op. 144, 219.

seven months of age, approximately  $4\frac{3}{4}$  inches in length, the size varying from about 3 inches to about  $7\frac{1}{2}$  inches, and in December they were of much the same size. It was estimated that the growth during the second year amounted to about 16.7cm., or a little over  $6\frac{1}{2}$  inches; that the average size of a cod when about two years of age was approximately a little over 13 inches; when about three years old about 20 inches; and when four years old about 27 or 28 inches; and that though some might reach a size equal to that of sexually mature males when three years of age, the great majority, and perhaps all, would not spawn till they were about four years old.

Since the publication of my paper on the growth of the cod, in the Annual Report for 1900, a number of investigations have been made on the same subject, which may be briefly referred to.

Dr. Petersen gave an estimate of the growth, in Danish waters, as follows:—In its first year it is between 1 and 8 inches long; in its second between 10 and 18; in its third between 20 and 30; and in its fourth year 30 inches and longer; and he states that this rate of growth is somewhat similar to what is given by me in the above paper. Measurements are not given by Dr. Petersen, except in certain cases, viz., of fish taken at the end of March by line, and two groups are shown—first, one in which the first year has been completed, and which measure from about 9cm. to about 22cm. ( $3\frac{1}{2}$ – $9\frac{1}{4}$  inches); and second, a group which have completed two years, and measure approximately from 27cm. to 52cm. or 53cm. ( $10\frac{5}{8}$ – $20\frac{1}{2}$  inches), the maximum number in each group being massed about 15cm. or 16cm. ( $6$ – $6\frac{1}{4}$  inches) and 36cm. to 39cm. ( $14\frac{1}{4}$ – $15\frac{1}{2}$  inches); while cod above 52cm. or 53cm. ( $20\frac{1}{2}$  inches) are described as of greater age.\*

In several of his papers dealing with the Norwegian fishery investigations, Hjort has given an account of the rate of growth of the cod. A length of between 8cm. and 16cm. ( $3\frac{1}{4}$ – $5\frac{3}{8}$  inches) is assigned to it in its first year, and between 18cm. and 24cm. ( $7\frac{1}{8}$ – $9\frac{1}{2}$  inches) in the second summer of its life, when it is about  $1\frac{1}{2}$  years old, which agrees with my results. In a table of measurements of cod taken on the south-west coast of Norway in August, the following sizes are shown:—(1) a group, about six months old, from 4 cm. to 13cm. ( $1\frac{5}{8}$ – $5\frac{1}{8}$  inches), most measuring 6cm. (2) A group, about  $1\frac{1}{2}$  years old, from 16cm. to 30cm. ( $6\frac{1}{4}$ – $11\frac{3}{4}$  inches), and most about 25cm. ( $9\frac{7}{8}$  inches). (3) A group, about  $2\frac{1}{2}$  years of age, from 32cm. to 42cm. ( $12\frac{5}{8}$ – $16\frac{1}{2}$  inches). All these groups agree with my own determinations.†

In another work on Norwegian fisheries, Hjort, referring to the cod on the coast of Finmarken, distinguishes four age-groups:—(1) One year old, about 20cm. long ( $7\frac{7}{8}$  inches). (2) When two years old, and known as "Finmarken cod" or "Lodde cod," and forming an important fishery on the Finmark coast, to which a length of 50cm., or  $19\frac{1}{2}$  inches, is assigned. (3) A group, at least three years of age, comprising the largest cod, and forming the basis of the "Skrei" fishery, and measuring about 70cm. in length ( $27\frac{1}{2}$  inches) ‡. It seems to me that the two last groups are probably too large; they do not, at least, agree with the rate of growth in the North Sea. No details of the measurements are furnished, except in a diagram, which shows the measurements of the Finmarken cod in April, and of the larger cod on the Malangsgrunden. A growth of 30cm. ( $11\frac{3}{4}$  inches) in a year from the first to the second group seems excessive.

In another paper, Hjort refers to the Danish investigations on the "Thor," referred to below, and mentions that with the cod taken by the

\* *Report of the Danish Biological Station, IX.*, pp. 4, 30.

† Hjort and Dahl, *Fiskeforsøg i Norske Fjorde*, pp. 75, 77.

‡ *Fiskeri og Hvalfangst i det Nordlige Norge*, pp. 50-53.

"Michael Sars" between Finmarken and Bear Island, the following groups appeared to exist, though he states that the material at disposal was not abundant or sufficient to make the distinction between the groups very clear:—(1) One year old, 10cm. to 30cm. (4-11½ inches); (2) 30cm. to 60cm. (11½-23½ inches); (3) 60cm. to 90cm. (23½-35½ inches). Detailed measurements are not given.\*

In connection with the Danish investigations at Iceland, Schmidt, in an important paper,† deals with the rate of growth of the cod, of which very large numbers were measured. His results at Iceland differ from those of other workers in other regions in certain respects. With the exception of the youngest group, the cod were taken on the east coast of the island, between Seydisfjord and Heradsfloi, with eel-seines, English trawls, and long-lines, in depths from 0-350 fathoms. The period was between 19th and 29th July, 1904. The youngest group, from 3cm. to 7cm., are not found in July on the east coast, and those of this series included in his tables and calculations as to age, were taken on 23rd August at Reykjarfjord, on the north coast, with an eel-seine in a few fathoms. These groups are as follows:—

Group.	Probable Age.	Range of Sizes.		Approximate Average Size.		Approximate Annual Growth.	
		Cm.	Inches.	Cm.	Inches.	Cm.	Inches.
1	½ year,	3-8	1¼-3¼	5	2		
2	1½ years,	9-17	3½-6¾	11 or 12	4½	6·5	2½
3	2½ "	18-30	7¼-11¾	22	8¾	10·0	3½
4	3½ "	30-45	11¾-17¾	33 or 34	13¼	11·5	4½
5	4½ "	45-81	17¾-32	61	24	27·5	10¾
6	5½ "	81-105	32-41½	88	34¾	27·0	10½

It will thus be seen that the growth of the cod at Iceland, according to these results, is abnormally slow in the early stages. That a small cod should grow only 2½ inches in a year, and reach an average length of only 4½ inches in the middle of its second summer, is remarkable, while the increase to the third summer is only 4½ inches. These Iceland cod, when approximately 3½ years of age, correspond to the cod in Scotland which are scarcely more than two years old. In the next year, to the middle of the fourth summer, the increase is very much greater—viz., about 10¾ inches; and the increase to the following summer, when they are supposed to be about 5½ years old, is also over 10 inches. The difference between these groups is brought out more strongly when the mean weight is considered, as well as the length of the fish. These are as follows, according to the Tables I published in the Report for 1903‡:—

\* Bericht über die Tätigkeit der Kommission A. August, 1902—Februar, 1904; p. 51.

† Fiskeriundersøgelser ved Island og Færøerne i Sommeren, 1903, pp. 62 et seq.

‡ Twenty-second Annual Report, Part III. "The Relation of Length to Weight," pp. 142, 229. I may take this opportunity of pointing out that Dr. Kyle, in his excellent paper on small plaice, "First Report on the Statistical Material received by the Bureau regarding the Quantities of Small Plaice landed in the Various Countries" (Conseil Permanent International pour l'Exploration de la Mer, Rapports et Procès-Verbaux, etc., Vol. IV.; Juillet 1904—Juillet 1905 (1905, p. 50), has, by an oversight, referred to my determinations as showing the fish at every 5 centimetres of length, instead of every 0·5 centimetre.

$\frac{1}{2}$ Year,	-	1.04 grammes, or	$\frac{1}{27}$ oz.
1 $\frac{1}{2}$ "	-	13.1 " "	$\frac{1}{2}$ "
2 $\frac{1}{2}$ "	-	97.4 " "	3 $\frac{1}{2}$ "
3 $\frac{1}{2}$ "	-	380.7 " "	13 $\frac{1}{2}$ "
4 $\frac{1}{2}$ "	-	2129 " "	4 lbs. 11 $\frac{1}{2}$ "
5 $\frac{1}{2}$ "	-	7000 " "	15 lbs. 10 $\frac{1}{2}$ "

The spawning period at Iceland is much the same as in the North Sea, and Dr. Schmidt found that the cod of the last group, with an average size of 88cm., and ranging from "a little under 70cm. and upwards," in July, had spawned in the spring, while those of the group, with an average of about 60cm. (24 inches), would spawn for the first time in the following year.

It may seem to one possible that the second group of small cod, with an average size of 4 $\frac{1}{2}$  inches, might have been spawned in the spring of the year, and that the smaller fish, taken on the north coast, have a different rate of growth there. It must be remembered, however, as Dr. Schmidt has so well shown, that the physical conditions, as temperature, vary very much at different parts of the coast of Iceland, and that the life and wanderings of the cod are influenced thereby. He, moreover, gives a table showing the growth of young cod at one place (Seydisfjord), and all taken in this case with one apparatus, the eel-seine, between 23rd May and 17th-23rd September, 1903. On 23rd May 180 measured from 7cm. to 11cm., with an average of about 9cm. (3 $\frac{1}{2}$  inches); on 23rd July 3300 measured from 10cm. to 17cm. (4-6 $\frac{3}{4}$  inches), the average size being placed by him at 12cm. (4 $\frac{3}{4}$  inches), though it might perhaps be better at 13cm.; on 17th-23rd September 1350 measured from 13cm. to 20cm. (5 $\frac{1}{8}$ -7 $\frac{7}{8}$  inches), the average being at 16cm. (6 $\frac{1}{4}$  inches). The first group thus grew about 3cm. (1 $\frac{1}{4}$  inches) in the two months May-July; in the two months from July to September the growth amounted to 4cm. (1 $\frac{1}{2}$  inches), and in the whole period of four months it amounted to 7cm., or 2 $\frac{3}{4}$  inches. In the September collection, moreover, 30 much smaller cod were obtained, measuring 4cm. and 5cm. (1 $\frac{1}{2}$ -2 inches), and relating these to the older group, and taking their average size at 4cm., the growth over the winter amount to only 5cm., or 2 inches, and from September to September it amounted to about 12cm., or 4 $\frac{3}{4}$  inches. These fish were caught between the shore and 5 fathoms depth.

A collection made with the eel-seine, from the shore to 6 $\frac{1}{2}$  fathoms, on 9th September, 1903, at Vaagfjord, Suder, in the Færøes, showed three groups:—(1) The young of the same year, 277 in number, measuring from 4cm. to 12cm. (1 $\frac{3}{4}$ -4 $\frac{3}{4}$  inches), with an average size of about 7cm. (2 $\frac{3}{4}$  inches); (2) a group of 87, measuring from 17cm. to 31cm. (6 $\frac{3}{4}$ -12 $\frac{1}{4}$  inches), about 1 $\frac{1}{2}$  years old, or more, and with an average size of about 25cm. (9 $\frac{3}{4}$  inches); (3) a group of 5 cod, from 37cm. to 41cm. (14 $\frac{1}{2}$ -16 $\frac{3}{8}$  inches). These results agree well with my own, and show an increase in the year of about 18cm. (7 $\frac{1}{8}$  inches).

Recently a good deal of attention has been given, especially by German investigators, to the growth of fishes as indicated by the markings on the bones, otoliths, and scales. Mr. Stuart Thomson investigated the age of cod by means of the markings on the scales. The specimens were taken on 26th August, and measured 20.9cm. (8 $\frac{1}{4}$  inches) and 25.1cm. (9.9 inches), and the age determined in each case was about one year and 4-5 months; the fish were thus well on in their second summer's growth. The result agrees with those obtained by me, as Mr. Thomson points out; they tally almost exactly with the collection on 22nd August, referred to in the Table below.



Most work of this kind, by making use of the hard structures of fish as a guide to their probable age, has been done by Professor Heincke and his coadjutors at the Biological Institute of Heligoland. The results are not yet fully published, but Professor Heincke has given some of his conclusions in two recent publications.\* The investigation was made on the cod on the German coast and at Heligoland, a fact to be kept in mind, as it is possible that on the shallow coast on the other side of the North Sea, where the saltness of the water is less than on this side, the cod grow less quickly than they do on the western side, as appears to be the case in the Baltic. Heincke estimates the size of the cod in the southern part of the North Sea as follows:—

Year.	Range of Sizes.		Average Size.		Increase.
	Cm.	Inches.	Cm.	Inches.	Cm.
In first year, . .	8-18	3½-7½	14	5½	
In second year, . .	—	—	about 27	10½	13
In third year, . .	—	—	35-40	13½-15½	10
In fourth year, . .	—	—	45-50	17½-19½	10

He says they have learned from a study of the bones that a cod of 50cm. (19½ inches) "has lived at most four complete years, and we believe—provisionally—that the cod does not spawn for the first time until it has lived four complete years, probably at the end of its fifth, at latest the sixth year." And, again, in the later paper, that it does not become sexually ripe until the completion of the fourth year, and perhaps only after the completion of the fifth year, when the average size is between 55cm. and 60cm. (21½-23½ inches).

After spawning, the rapidity of growth diminishes, as in other fishes, so that a cod of 75cm. (29½ inches) is at least 7 years, and probably 8-9 years old; one of 85cm. (33½ inches) at least 8, and probably 9 or 10 years old, and one of 100cm. at least 10, and probably 12 or more years of age. Young cod, under one year of age, were found to grow in the aquarium at Heligoland, when well fed, not less than 1mm. daily (or at a rate of about 1½ inches a month) from the beginning of August to the middle of September, and from the middle of September to the end of October ½ to ¾ of a millimetre daily; and it is stated that growth in the open sea would certainly be greater. As stated in my previous paper, a cod of 11½ inches in the tank at the Laboratory at Aberdeen grew to 12½ inches between 28th August and 26th September, or at the rate of a millimetre per day.

Mr J. T. Cunningham has also studied the rate of growth or age of cod by the markings on the hard structures, but his conclusions do not quite agree with those of Professor Heincke, and he differs also as to the structures best fitted to show the growth.† Professor Heincke found the otoliths and scales much less satisfactory than the bones, and particularly the coracoid and scapula, especially in the cod, "which, for the rest," he says, "is one of the most difficult species on which to determine the age." On the other hand, Cunningham found these bones and others of the cod unsuitable for the determination of the age, it being impossible, he says, to distinguish with certainty the annual rings or zones. Speaking of the

\*"The Occurrence and Distribution of the Eggs, Larvæ, and Various Age-Groups of the Food-Fishes in the North Sea." Conseil Perm. Intern. pour L'Explor. de la Mer. General Report on the Work of the Period, July, 1902-July, 1904, p. 29, 30; Die Beteiligung Deutschlands an der Internationalen Meeresforschung, III. Jahresbericht, p. 75.

† Twenty-third Annual Report Fishery Board for Scot., Part III., p. 131 et seq.

zones of the vertebrae, he says "one may count three at one time, and at the next attempt there seem to be four or five, and the total number always remains doubtful and uncertain." He found that transverse slices of the otoliths showed the markings much better, and he chiefly used them in determining the age of the specimens of cod he studied. Here are some of the results, though doubt is expressed as to the certainty of the determination in some cases:—

Caught 9th November.			Caught 9th March.		
Length.		Probable Age.	Length.		Probable Age.
Cm.	Inches.		Cm.	Inches.	
47	18½	about 2½ years	24·3	10	2 years
54	21½	3½ "	30·5	12½	2 "
64	25½	3½ "	30·7	12½	2 "
		possibly 2½ "	33·5	13½	2 "
73	29½	3½ "	44·3	17½	3 "
			45·6	18½	3 "
			67·5	27	4 "

According to these later results, Mr. Cunningham says, the cod at two years of age is 10 to 13 or 14 inches in length, at three years 17 to 19 inches, at four years 27 inches; but, he adds, it would require the examination of a large number of specimens to ascertain the average and range of sizes at these ages. So far as these results go, they are in agreement with my own derived from the method of measuring the fishes.

Lately Dr. S. Strodtmann published a paper on the spawning and migrations of fish in the Baltic, which contains some observations on the growth of young cod, taken in Travemünder Bucht.\*

A series numbering 555, taken on 15th October, 1904, measured from 5cm. to 16cm. (2–6½ inches), the average being 10·0cm., or barely 4 inches. A month later, November 14th, 743 ranged from 5cm. to 15cm., the average being 10·5cm. On December 12th, 333 measured from 7cm. to 19cm (2½–7½ inches), the average being 13·5, or 5½ inches. At the beginning of March in the following year they ranged from 9cm. to 17cm., and numbered 75, the average size being 12·8cm., and at the beginning of April 123 ranged from 9cm. to 17cm., the average being 13cm., or 5½ inches. These results agree closely with my own. On September 9th, 84 measured between 16cm. and 30cm. (6½–11½ inches), the average being 21·5cm. (8½ inches), which is also near what will be found in the Tables appended.

It will be noticed that the young cod in December are rather larger than in either March or April, while from November to December they appear to have grown 3cm., which Dr. Strodtmann considers to be improbable at that season. In the course of the summer they increased by 8·5cm., or 3½ inches. He compares the growth at the place indicated with the growth of young cod at Büsum, on the North Sea, and shows that the latter at the beginning of October had a greater range of size and a larger average size than in the Baltic at the middle of the month. The Baltic fish ranged from 5cm. to 15cm., according to the diagram, the average being 10cm., while the North Sea cod ranged from 5cm. to 16cm. or 17cm., and the average was 12cm. or 13cm. (4½–5½ inches. At Aberdeen in the same month the average was 12cm. also.

In the Tables appended to this paper will be found the measurements of the cod I have dealt with, grouped into centimetres, and the following

\* *Laichen und Wandern der Ostseefische*, p. 209.

Tables show details of these and the arrangement into the various series or generations. In some cases, where the number of cod in the collections was fairly large, the distinction of one group from another was tolerably easy, especially when the millimetre measurements and tables were consulted as well as the diagrams or curves. All the measurements were made to millimetres, and curves were constructed of each collection. In other cases, the division of one series from another is only approximate, and one or two or several fish may belong to one or the other. For example, in the collections from Aberdeen Bay, the chief group in July might terminate at 32cm. or 34cm. instead of at 28cm., so far as these measurements by themselves indicate; but this interpretation would be opposed to the limits of the group later in the year. It will be often found, as in the July collections, that a few fish at the end of what may appear to be a compact series are considerably larger than the others and separated from them by a good interval; and it is difficult to decide whether they should be looked upon as stragglers from that series—fish which have grown much quicker than their fellows—or stragglers from the next larger series, which may not be well represented.

COD.

Date.	Group	No.	Range of Size.		Modal Size.	Approximate Mean Length.		Approximate Age.		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.	Cm.	Inch.
I.—ABERDEEN BAY—											
January 15, 1902	I.	7	9.7-16.2	3½-6½	9-11	12.5	5	..	9½	..	..
	II.	15	26-40	10½-15½	30	31-32	12-12½	1	9½	19	7½
	III.	3	48-59	19-23	..	..	..	2	9½	..	..
February 11, 1905,	I.	16	8-17	3½-6½	9-10	12.5	5	..	10½	..	..
March 29, 1905	I.	6	9-19	3½-7½	..	13.5	5½	1	..	..	..
May 13, 1902,	II.	5	14-20.7	5½-8½	..	..	..	1	1½	..	..
	III.	5	27-34	10½-13½	..	..	..	2	1½	..	..
June 13, 1901,	II.	31	14.3-23	5½-9½	18	18.5	7½	1	2½	..	..
June 28, 1901,	II.	19	19-26	7½-10½	21	22	8½	1	3	..	..
	..	2	29-36	..	..	..	..	2	3	..	..
	..	6	54-60	21¼-23¼	..	..	..	..	..	..	..
July 30, 1901,	I.	1	6.5	2⅝	..	..	..	..	4	..	..
	II.	43	16.7-28	6½-11	23	23	9½	1	4	..	..
	III.	26	29.3-46	11⅝-18½	..	..	..	2	4	..	..
	..	1	49.8	..	..	..	..	..	..	..	..
July 31, 1901,	II.	32	16.7-27.9	6½-11	19-23	22.5	8½	1	4	..	..

COD.—continued.

Date.	Group	No	Range of Size.		Modal Size.	Approximate Mean Length		Approximate Age.		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.	Cm.	Inch.
1.—Aberdeen Bay— continued.											
August 21, 1901 -	I.	18	6-5-8-8	2 $\frac{1}{2}$ -3 $\frac{1}{2}$	8	7.7	3	...	4 $\frac{1}{2}$	..	..
	II.	85	18-7-32-3	7 $\frac{1}{2}$ -12 $\frac{1}{2}$	22	23.5	9 $\frac{1}{2}$	1	4 $\frac{1}{2}$	15-8	6 $\frac{1}{2}$
	III.	12	36-4-48-7	14 $\frac{1}{2}$ -19 $\frac{1}{2}$	..	..	..	2	4 $\frac{1}{2}$	..	..
	..	6	51-3,53	..	..	..	..	3	4 $\frac{1}{2}$	..	..
	..	..	58-5	..	..	..	..	..	..	..	..
	..	..	60-8 61,63	..	..	..	..	..	..	..	..
September 3, 1901, -	II.	93	18-4-32	7 $\frac{1}{2}$ -12 $\frac{1}{2}$	25	25	9 $\frac{1}{2}$	1	5	..	..
	III.	8	39-4-45	15 $\frac{1}{2}$ -17 $\frac{1}{2}$	..	..	..	2	5	..	..
	IV.	6	50-61	19 $\frac{1}{2}$ -24	..	..	..	3	5	..	..
September 4, 1901, -	I	14	22-3-32	8 $\frac{1}{2}$ -12 $\frac{1}{2}$	25	..	..	1	5	..	..
September 4, 1901, -	II.	24	20-7-29-9	8 $\frac{1}{2}$ -11 $\frac{1}{2}$	25	..	..	1	5	..	..
September 4, 1901, -	I.	1	8-3	3 $\frac{1}{2}$	..	..	..	..	5	..	..
	II.	29	19-4-29-8	7 $\frac{1}{2}$ -11 $\frac{1}{2}$	25, 27	..	..	1	5	..	..
September 4, 1901, - (Three hauls combined.)	I.	1	8-3	3 $\frac{1}{2}$	..	..	..	..	5	..	..
	II.	67	19-4-32	7 $\frac{1}{2}$ -12 $\frac{1}{2}$	25	25	9 $\frac{1}{2}$	1	5	..	..
September 10, 1901, -	I.	41	6-0-15-3	2 $\frac{1}{2}$ -6	9	9.5	3 $\frac{1}{2}$	..	5 $\frac{1}{2}$	..	..
	II.	7	18-1-29-3	7 $\frac{1}{2}$ -11 $\frac{1}{2}$	..	..	..	1	5 $\frac{1}{2}$	..	..
September 3-10, 1901, - (Combined.)	I.	42	6-0-15-3	2 $\frac{1}{2}$ -6	9	9.5	3 $\frac{1}{2}$	..	5-5 $\frac{1}{2}$	..	..
	II.	167	18-1-32	7 $\frac{1}{2}$ -12 $\frac{1}{2}$	25	25	9 $\frac{1}{2}$	1	..	15-5	6 $\frac{1}{2}$
	III.	8	39-4-45	15 $\frac{1}{2}$ -17 $\frac{1}{2}$	..	..	..	2	..	..	..
	IV.	6	50-61	19 $\frac{1}{2}$ -24	..	..	..	3	..	..	..
October 18, 1901 -	I.	75	7-8-19-9	3 $\frac{1}{2}$ -7 $\frac{1}{2}$	12	12	4 $\frac{1}{2}$	..	6 $\frac{1}{2}$	..	..
	II.	37	22-2-35-8	8 $\frac{1}{2}$ -14 $\frac{1}{2}$	26	28.5	11 $\frac{1}{2}$	1	6 $\frac{1}{2}$	16-5	6 $\frac{1}{2}$
	..	2	51-8-56-0	..	..	..	..	..	..	..	..
October 31, 1903, -	I.	21	4-8-15-7	1 $\frac{1}{2}$ -6 $\frac{1}{2}$	9 & 11	12	4 $\frac{1}{2}$	..	7	..	..
	II.	13	22-7-36-0	8 $\frac{1}{2}$ -14 $\frac{1}{2}$	25-27	29	11 $\frac{1}{2}$	1	7	17	6 $\frac{1}{2}$
	III.	5	39-5-53-3	15 $\frac{1}{2}$ -21 $\frac{1}{2}$	..	..	..	2	7	..	..
	..	1	55-7	..	..	..	..	..	..	..	..
	..	5	60-6-77-8	27 $\frac{1}{2}$ -30 $\frac{1}{2}$	..	..	..	..	..	..	..

COD—continued.

Date.	Group	No.	Range of Size.		Modal Size.	Approximate Mean Length		Approximate Age.		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.	Cm.	Inch.
I.—Aberdeen Bay— continued—											
November 5, 1901,	II.	20	26.7-35.9	10½-14½	30	30.5	12	1	7	..	..
	III.	5	46.4-52	18½-20½	..	..	..	2	7	..	..
	..	2	56.8-57.4	..	..	..	..	..	..	..	..
November 6, 1901,	I.	301	8.6-19.0	3½-7½	11	12	4½	..	7	..	..
November 5 and 6, (Combined.)	I.	301	8.6-19.0	3½-7½	11	12	4½	..	7	..	..
	II.	20	26.7-35.9	10½-14½	30	30.5	12	1	7	18.6	7½
November 28, 1901	I.	1	18.7	..	..	..	..	..	8	..	..
	II.	43	23.8-38.1	9½-15	31	32	12½	1	8	..	..
	III.	12	39.7-53.8	15½-21½	..	[47	18½]	2	8	[15	5½]
November 29, 1901	I.	37	7.8-20.7	3¼-8¼	10	10 [13	3½ 5½]	..	8	..	..
	II.	135	21.8-38.3	8½-15½	31	31	12½	1	8	18	7½
	III.	21	39.2-57.3	12½-22½	..	[47	18½]	2	8	16	6½
November 28 and 29, (Combined.)	I.	38	7.8-20.7	3¼-8¼	10	[13	5½]	..	8	..	..
	II.	178	21.8-38.3	8½-15½	31	31	12½	1	8	18	7½
	III.	33	39.2-57.3	15½-22½	..	[47	18½]	2	8	16	6½
December 16, 1901	I.	18	8.3-20.8	3¼-8¼	10	13	5½	..	8½	..	..
	II.	70	23-41.8	9-16½	32	32	12½	1	8½	18	7½
	..	1	51	..	..	..	..	..	..	..	..
December 12, 1904	II.	16	31.9-42.2	12½-16½	..	..	..	1	8½	..	..
	III.	35	43.7-61.6	17½-24½	..	[49.5	19½]	2	8½	..	..
	IV.	33	66.3 66.9-67.1	26-26½	..	..	..	3	8½	..	..
II.—MORAY FIRTH. Dornoch Firth—											
February 9, 1905,	I.	7	8.5-16.2	3½-6½	..	..	..	..	10	..	..
June 9, 1903,	I.	25	3.3-4.8	1¼-1¾	3.5	4.0	1¾	..	2½	..	..
October, 22, 1903,	I.	3	6.6-9.8	2½-3¾	..	..	..	..	7	..	..
	II.	2	21.0-31	8½-12¾	..	..	..	1	7	..	..
	III.	3	42.3-47.4	16½-18½	..	..	..	2	7	..	..

COD—continued.

Date.	Group	No.	Range of Size.		Modal Size	Approximate Mean Length		Approximate Age.		Apparent Growth from Preceding Series	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.		
II.—Moray Firth—cont.										Cm.	Inch.
November 9-10, 1901, -	I.	78	9-7-19-1	3½-7½	12	12-5	4½	..	7½	..	..
	II.	113	20-7-36-7	8½-14½	25	27-5	10½	1	7½	15	5½
	III.	4	43-3-52-8	17-20½	..	..	..	2	7½	..	..
November 12, 1903 -	I.	4	12-5-20-5	4½-8½	..	..	..	..	7½	..	..
	II.	6	25-7-34-3	10½-13½	..	..	..	1	7½	..	..
	III.	16	44-8-61-0	17½-24	..	..	..	2	7½	..	..
	IV.	10	66-4-76	25½-30	..	..	..	3	7½	..	..
	V.	10	79-89	31-35	..	..	..	..	..	..	..
	..	3	97, 105, 106	..	..	..	..	..	..	..	..
December 7, 1904, -	I.	13	7-7-11-9	3-4½	..	..	..	..	8	..	..
	II	2	25-6-27-7	..	..	..	..	1	8	..	..
December 19, 1901, -	II.	41	25-41-6	9½-16½	33	31	12½	1	8½	..	..
	III.	15	46-0-60-0	18-23½	..	..	..	2	8½	..	..
Smith's Bank, -	I.	4	12-8-20-3	5½-8	..	..	..	1	..	..	..
April 1, 1904, -	II.	22	23-1-38-8	9½-15½	23	..	..	2	..	..	..
	III.	7	46-59	17½-23½	..	..	..	3	..	..	..
October 23, 1903, -	I.	3	7-2-12-6	2½-5	..	..	..	..	7	..	..
	II.	6	23-2-39-6	9½-15½	..	..	..	1	7	..	..
November 8, 1901, -	I.	4	9-8-13-9	3½-5½	..	..	..	..	7½	..	..
	II.	42	25-9-40-1	10½-15½	29	31-5	12½	1	7½	..	..
December 27, 1903, -	II.	33	25-0-37-5	9½-14½	30	30	11½	1	9	..	..
	III.	3	45-6-50-2	..	..	..	..	..	..	..	..
Burghead Bay— September 7, 1901 -	I.	1	10-6	..	..	..	..	..	5½	..	..
	II.	34	20-7-32-3	8½-12½	25	26	10½	1	5½	..	..
October 20, 1903 -	I.	4	16-0-15-4	4-6½	..	..	..	..	6½	..	..
	II.	15	30-9-29-4	8½-11½	..	..	..	1	6½	..	..
December 6, 1904, -	II.	32	21-4-33-2	8½-13½	25	27	10½	..	8½	..	..

COD—continued.

Date.	Group	No.	Range of Size.		Modal Size.	Approximate Mean Length		Approximate Age		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.	Cm.	Inch.
II—Moray Firth—cont.											
December 20-25, 1901,	I.	91	10.5-21.9	4½-7½	1.	15	5½	9			
	II.	179	22.9-39.8	9-15½	26	30.5	12	1	9	15.5	6½
	III.	40	40.3-59.8	15½-23½		48	18½	2	9	17.5	6½
	IV.	67	61.2-72.4	24-28½				3	9		
		6	76.6-84.5	30-33½							
		10	91-100	36-39½							
		3	101.102.103	39½-40½							
	1	110	43½								
December 29, 1903,	II.	8	26-39.8	10½-15½							
	III.	3	43.2-45.4	17-17½							
			73, 90, 98								
			100, 101, 103, 104,								
Cronkarty Firth, January 7, 1901,	I.	16	8.7-22.2	3½-8½					9½		
	II.	22	25.8-39.3	10½-15½				1	9½		
Off Lybster, Caithness.											
October 23, 1903.	I.	6	5.8-14.3	2½-5½					6-7		
	II.	3	24.8-32.4					1			
November 8, 1901,	II.	114	26.8-37.8	10½-14½	32	32	12½	1	7½		
Off Dunbeath, Caithness											
January 17-18, 1902	I.	17	13.8-23.3	5½-8½					9½		
	II.	280	23.1-40.7	9½-16	31	31.5	12½	1	9½		
	III.	41	41.9-62.5	16½-24½		[50	19½]	2	9½		
Sinclair Bay—											
June 4, 1901,	III.	20	26.6-36.3	10½-14½				2	2		
	IV.	13	40.5-56.5	16-22½				3	2		
		2	65.3-68.7								
III.—FIRTH OF FORTH.											
May 13-16, 1901,	II.	145	9.6-23.0	3½-9½	13	15	5½	1	1½		
	III.	3	25-27								
July 23, 1901	I.	29	4.6-8.4	1½-3½	5	6 (5)	2½ (2)		4		
	II.	77	15.2-30	6-11½	20	22	8½	1	4	17	6½
	III.	2	32.2-33.8								

COD—continued.

Date.	Group	No.	Range of Size.		Modal Size.	Approximate Mean Length		Approximate Age		Apparent Growth from Preceding Series.	
			Cm.	Inches.		Cm.	Inch.	Years	M'ths.		
III.—Firth of Forth— continued.											
August 19, 1901,	I.	90	5.4-11.3	2½-4⅞	7	7.5	3	..	4½-5	..	..
	II.	93	14.8-31.6	5⅞-12⅞	21	22.5	8⅞	1	4½-5	15	5½
August 22, 1901, .	I.	46	5.8-13.2	2¼-5⅞	7	8	3½	..	4½-5	..	..
	II.	47	16.8-29.7	6⅝-11¾	22	22.5	8⅞	1	4½-5	14.5	5½
August 21, 1901, .	I.	10	6.4-7.9	2½-3½	7	7	2¾	..	4½-5	..	..
	II.	19	18.8-29.2	7¾-11½	22	23.5	9¼	1	4½-5	16.5	6½
August 19-22, . (Combined.)	I.	146	5.4-13.2	2¼-5⅞	7	7.5	3	..	4½-5	..	..
	II.	159	14.8-31.6	5⅞-12⅞	21	22.5	8⅞	1	4½-5	15	5½
IV.—OFF SHETLAND ISLES											
May 19-22, 1901,	II.	3	18.1-23.7	7¼-9¾	..	..	..	1	1½	..	..
	III.	268	25.2-41.2	9½-16½	32	32.5	12¾	2	1½	..	..
	IV.	141	41.8-61.6	16-24½	50	50	19¾	3	1½	18	7½

The first series, that is, cod in their first year, comprises over 900 specimens, and they are present in greater or less numbers in thirty-four of the collections.

They first appeared in a collection made in the Dornoch Firth on 9th June 1903, the haul being made with the small-meshed net around the cod-end of the otter trawl, in from 8 to 11 fathoms. Twenty-five were taken measuring from 33mm. to 48mm. ( $1\frac{5}{8}$ - $1\frac{7}{8}$  inches), the average size being 38.8 mm., or a trifle over  $1\frac{1}{2}$  inches. These young cod were approximately  $2\frac{1}{2}$  months old. It is of interest to note that on 30th March in the following year (1904), a shoal of spawning cod of large size were discovered on the same ground, a little further off, in from 13 to 15 or 16 fathoms.\*

They next appear in the collections of 30th July, in Aberdeen Bay, and of 23rd July in the Firth of Forth. In the latter case 29 were obtained, measuring from 4.6cm. to 8.4cm. ( $1\frac{3}{8}$ - $3\frac{1}{8}$  inches), and with an average size of about 6cm., or  $2\frac{3}{8}$  inches. The arithmetical average was 61.3mm. An examination of the curve shows that the smaller cod are not duly represented, the rise from 4cm. to 5cm. being very abrupt; more probably 2.5cm. or 3cm. would indicate the lower limit of the group, and 5cm., or 2 inches, the average size. In the collections made in the Firth of Forth from 19th to 22nd August, or nearly a month later than the above, the range in size of 146 specimens was from 5.4cm. to 13.2cm. ( $2\frac{1}{8}$ - $5\frac{3}{8}$  inches), and the average size was about 7cm., or  $2\frac{3}{4}$  inches, an increase of about 2cm., or  $\frac{3}{4}$  of an inch (fig. 5, pl. XII.).

\* Vide *Twenty-third Annual Report*. Part III, p. 21.



In Aberdeen Bay, 18, obtained on 21st August, measured from 6.5cm. to 8.8cm. ( $2\frac{9}{16}$ – $3\frac{1}{2}$  inches), the average size being 7.7cm., or 3 inches. In collections from the 3rd to the 10th September, the range of the 42 specimens was from 6cm. to 15.3cm. ( $2\frac{3}{8}$ –6 inches), the average size being 9.5cm., or  $3\frac{3}{4}$  inches (fig. 6, pl. XII.). On 18th October 75 measured from 7.8cm. to 19.9cm. ( $3\frac{1}{8}$ – $7\frac{7}{8}$  inches), the average size being 12cm., or  $4\frac{3}{4}$  inches. On the 31st of the same month, but in a different year, 21 ranged from 4.8cm. to 15.7cm. ( $1\frac{7}{8}$ – $6\frac{3}{8}$  inches), the average size being 12cm., or  $4\frac{3}{4}$  inches. A week later, on the 6th November, a large collection of 301 had a range from 8.6cm. to 19cm. ( $3\frac{3}{8}$ – $7\frac{1}{2}$  inches), the average being 12cm., or  $4\frac{3}{4}$  inches, the same as on 18th October. At the end of the month, on the 28th and 29th, 38 measured from 7.8cm. to 20.7cm. ( $3\frac{1}{8}$ – $8\frac{3}{16}$  inches), the average being approximately 13cm., or  $5\frac{1}{8}$  inches; and on 16th December in the same year, 18 ranged from 8.3cm. to 20.8cm. ( $3\frac{1}{4}$ – $8\frac{5}{8}$  inches), also with an approximate average of 13cm.

At the middle of January, 7 ranged from 9.7cm. to 16.2cm. ( $4\frac{1}{8}$ – $6\frac{3}{8}$  inches), the average size being about 12.5cm., or 5 inches. Then on 11th February in another year, 16 were from 8cm. to 17cm. ( $3\frac{1}{8}$ – $6\frac{3}{4}$  inches), the average being the same, and on 29th March, the last collection from Aberdeen Bay containing fish under one year of age, 6 ranged from 9cm. to 19cm. ( $3\frac{1}{2}$ – $7\frac{1}{2}$  inches), the average size being about 13.5cm., or  $5\frac{3}{8}$  inches.

It will thus be seen that the young cod increase in size rapidly in the summer and up to October, and that after that to March the increase appears to be but slight. The numbers obtained in the winter and early spring were, however, small. The increase from August to the end of the year was about 2 inches or a little more.

The collections of cod under one year of age from other parts of the east coast are, as a rule, small, but one or two are fairly large. In the Dornoch Firth, on 9th and 10th November, 78 measured from 9.7cm. to 19.1cm. ( $3\frac{1}{8}$ – $7\frac{1}{2}$  inches), and the average size was about 12.5cm., or  $4\frac{1}{8}$  inches (fig. 6, pl. XII.). In Burghead Bay, also in the Moray Firth, on 20th and 25th December, in another year, 91 ranged in length from 10.5cm. to 21.9cm. ( $4\frac{1}{8}$ – $7\frac{5}{8}$  inches), the average size being about 15cm., or  $5\frac{1}{2}$  inches. In the Cromarty Firth, on 7th January, 16 measured from 8.7cm. to 22.2cm. ( $3\frac{1}{4}$ – $8\frac{3}{4}$  inches), and on 17th January, in another part of the Moray Firth, 17 ranged in length from 13.8cm. to 22.3cm. ( $5\frac{1}{2}$ – $8\frac{3}{4}$  inches), but these fish were taken in the ordinary trawl-net, and the smaller specimens are not duly represented.

The collections when the cod is one year of age, in April or the end of March, are not sufficient to show with precision its size at that period, but, from what has been said and from what follows as to the size a little later, it may be placed at about  $5\frac{1}{2}$  or  $5\frac{1}{4}$  inches (13cm. or 14cm.), with a range from 3 to 8 inches or a little more (7.5cm. to 20cm.). The growth of the cod in its second year appears to be somewhat more rapid, probably owing to its becoming more and more piscivorous in its feeding.

The second series, comprising cod in their second year, is well represented by over 2000 fish in 48 of the collections. The growth in summer is rapid. In Aberdeen Bay, 5 taken on 13th May ranged from 14cm. to 20.7cm. ( $5\frac{1}{2}$ – $8\frac{1}{8}$  inches). In the Firth of Forth, 145, caught between 13th and 16th May, measured from 9.6cm. to 23cm. ( $3\frac{3}{4}$ – $9\frac{1}{8}$  inches), with an average length of 15cm., or  $5\frac{1}{4}$  inches. On 1st April, 4 caught at Smith Bank, in the Moray Firth, were from 12.8cm. to 20.3cm. ( $5\frac{1}{8}$ –8 inches), and 3 taken in deep water off the Shetlands on 19th and 22nd May were from 18.1cm. to 23.7cm., or between  $7\frac{1}{8}$  and  $9\frac{3}{8}$  inches.

On 13th June, in Aberdeen Bay, 31 specimens, computed to be about 1 year and 2½ months old, measured from 14·3cm. to 23cm. ( $5\frac{3}{8}$ – $9\frac{1}{8}$  inches), the mean size being 18·5cm., or  $7\frac{1}{4}$  inches. On the 28th, 19 caught in the "Doghole," in 65 fathoms, ranged from 19cm. to 26cm. ( $7\frac{1}{2}$ – $10\frac{1}{4}$  inches), the mean being 22cm., or  $8\frac{5}{8}$  inches; the arithmetically computed average was 21·9cm.

In July two collections were made in Aberdeen Bay and one in the Firth of Forth. In the former, on the 30th, 43 measured from 16·7cm. to 28cm. ( $6\frac{5}{8}$ –11 inches), the average being 23cm., or  $9\frac{1}{8}$  inches; these were taken at the "Doghole," in 62 fathoms. On the next day, 32, caught in 11–13 fathoms, ranged from 16·7cm. to 27·9cm., or the same, the average length being a little less, viz., about 22·5cm., or  $8\frac{7}{8}$  inches.

On the 23rd the collection in the Firth of Forth comprised 77 specimens, about 1 year and 4 months old; they ranged from 15·2cm. to 30 cm. ( $6$ – $11\frac{1}{2}$  inches), the average being 22cm., or  $8\frac{5}{8}$  inches.

On 21st August, 85, from the "Doghole," in 58 fathoms, were from 18·7cm. to 32·3cm. ( $7\frac{3}{8}$ – $12\frac{3}{4}$  inches), the average being about 23·5cm., or  $9\frac{1}{4}$  inches. Their age was about 1 year and 4 or 5 months. In the Firth of Forth they were represented in three collections in August, as follows:—On the 19th, 93 varied from 14·8cm. to 31·6cm. ( $5\frac{1}{2}$ – $12\frac{1}{4}$  inches), the average being 22·5cm., or  $8\frac{7}{8}$  inches; on the 21st, 19 ranged from 18·8 to 29·2cm. ( $7\frac{3}{8}$ – $11\frac{1}{2}$  inches), the average being 23·5cm., or  $9\frac{1}{4}$  inches; on the 22nd, 47 measured from 16·8cm. to 29·7cm. ( $6\frac{5}{8}$ – $11\frac{1}{2}$  inches), the average being 22·5cm., or  $8\frac{7}{8}$  inches (fig. 5, pl. XII.).

In September, in Aberdeen Bay, 167 were caught between the 3rd and 10th; they ranged in length from 18·1cm. to 32cm. ( $7\frac{1}{8}$ – $12\frac{5}{8}$  inches), the average being about 25cm., or  $9\frac{7}{8}$  inches. At Burghhead Bay, on 7th September, 34 ranged from 20·7cm. to 32·3cm. ( $8\frac{1}{8}$ – $12\frac{1}{4}$  inches), the mean size being about 26cm., or  $10\frac{1}{4}$  inches (fig. 6, pl. XII.). These fish were one year and five or six months old.

Several collections were got in October. In Aberdeen Bay, on the 18th, 37 measured from 22·2cm. to 35·8cm. ( $8\frac{3}{4}$ – $14\frac{1}{8}$  inches), the mean being 28·5cm., or  $11\frac{1}{4}$  inches. On the 31st, 13 ranged from 27·8cm. to 36cm. ( $8\frac{1}{2}$ – $14\frac{3}{8}$  inches), the mean being about 29cm., or  $11\frac{7}{8}$  inches. The numbers of this series in the October collections from the Moray Firth are small. In the Dornoch Firth, on the 22nd, two measured 21·9cm. and 31cm.; at Smith Bank, on the 23rd, six ranged from 23·2cm. to 39·6cm. ( $9\frac{1}{8}$ – $15\frac{1}{2}$  inches; in Burghhead Bay, on the 20th, 15 measured from 20·9cm. to 29·4cm. ( $8\frac{1}{4}$ – $11\frac{1}{2}$  inches); and on the 23rd, off Lybster, on the coast of Caithness, three were from 24·8cm. to 32·4cm.

On 5th November, at the "Doghole," in 70 fathoms, 20 of this series were obtained; they ranged from 26·7cm. to 35·9cm.  $10\frac{1}{2}$ – $14\frac{1}{8}$  inches), the mean being about 30·5cm., or 12 inches. On the 28th, 43, taken with the ordinary trawl-net in Aberdeen Bay, measured from 23·8cm. to 38·1cm. ( $9\frac{3}{8}$ –15 inches), the mean being about 32cm., or  $12\frac{5}{8}$  inches. On the following day a collection of 135 belonging to this series ranged from 21·8cm. to 38·3cm. ( $8\frac{5}{8}$ – $15\frac{1}{8}$  inches), the mean being 31cm., or  $12\frac{1}{4}$  inches. These were about 1 year and 8 months old.

In the Dornoch Firth, on the 9th and 10th, 113 measured from 20·7cm. to 36·7cm. ( $8\frac{1}{8}$ – $14\frac{7}{8}$  inches), the average length being about 27·5cm., or  $11\frac{1}{2}$  inches (fig. 6, pl. XII.). At Smith Bank, on the 8th, 42 ranged from 25·9cm. to 40·1cm. ( $10\frac{3}{8}$ – $15\frac{3}{4}$  inches), the mean being 31·5cm., or  $12\frac{3}{8}$  inches. Off Lybster, on the 8th, 114 measured from 26·8cm. to 37·8cm., ( $10\frac{1}{2}$ – $14\frac{3}{8}$  inches), the average being 32cm., or  $12\frac{5}{8}$  inches.

In December, in Aberdeen Bay, 70 measured from 23cm. to 41·8cm.

(9-16 $\frac{3}{8}$  inches), the average being 32cm., or 12 $\frac{5}{8}$  inches. The largest member of the group in this case might be one at 38.6cm. (15 $\frac{1}{4}$  inches), as in the November collections, but in that of 12th December the division is not so placed. In the latter, 16 measured from 31.9cm. to 42.2cm. (12 $\frac{1}{4}$ -16 $\frac{3}{8}$  inches).

In the Dornoch Firth, on 19th December, 41 measured from 25cm. to 41.6cm. (9 $\frac{7}{8}$ -16 $\frac{3}{8}$  inches), the mean being about 31cm., or 12 $\frac{1}{4}$  inches. At Smith Bank, on the 27th December, 33 ranged from 25cm. to 37.5cm. (9 $\frac{7}{8}$ -14 $\frac{1}{2}$  inches), the next fish measuring 45.6cm.; the average size was about 30cm., or 11 $\frac{3}{4}$  inches. On 6th December, at Burghead Bay, 32 measured from 21.4cm. to 33.2cm. (8 $\frac{7}{16}$ -13 $\frac{1}{8}$  inches), the mean being about 27cm., or 10 $\frac{5}{8}$  inches. In this collection, as the other tables of measurements show, the larger fishes of the series were not present in due numbers, and the two smaller fishes, 21.4cm. and 21.8cm., may belong to the younger series, which is not otherwise represented.

A large collection of this series was obtained in Burghead Bay between the 20th and 25th December. They numbered 179, ranging from 22.9cm. to 39.8cm. (9-15 $\frac{5}{8}$  inches), the average size being about 30.5cm., or 12 inches. A small collection on the 29th of the same month in another year, comprised 8 specimens of this series, their sizes ranging from 26cm. to 39.8cm. (10 $\frac{1}{4}$ -15 $\frac{5}{8}$  inches) (fig. 5, pl. XII.).

In January, in Aberdeen Bay, 15 of this series measured from 26cm. to 40cm. (10 $\frac{1}{4}$ -15 $\frac{3}{4}$  inches), the mean being 31cm. to 32cm., or 12 $\frac{1}{2}$  inches. In the Cromarty Firth, on the 7th, 22 were from 25.8cm. to 39.3cm. (10 $\frac{3}{8}$ -15 $\frac{1}{2}$  inches), the mean being about 32cm., or 12 $\frac{5}{8}$  inches. A large collection was obtained off Dunbeath, on the Caithness coast, on 17th January, and the 280 cod comprised in the series measured from 23.1cm. to 40.7cm. (9 $\frac{1}{8}$ -16 inches), the average being about 31.5cm., or 12 $\frac{3}{8}$  inches. These fish were obtained in the ordinary trawl-net, but at this size the fact will not affect the average to any material extent.

No cod of this series were in the collections in February and March. On 1st April, 22, caught at Smith Bank, in the Moray Firth, ranged in length from 23.1cm. to 38.8cm. (9 $\frac{1}{8}$ -15 $\frac{1}{2}$  inches), but the higher limit of the series is less than it ought to be from the absence of the larger fishes; the next longest to the one at 38cm. was one about 46cm. In May (when they were over two years old) five taken in Aberdeen Bay measured from 27cm. to 34cm. (10 $\frac{5}{8}$ -13 $\frac{3}{8}$  inches), and three in the Firth of Forth were from 25cm. to 27cm. (9 $\frac{7}{8}$ -10 $\frac{5}{8}$  inches). The numbers are too small, of course, on which to base a conclusion. In a large collection made up of the cod taken in several hauls of the ordinary trawl-net in deep water off the Shetlands (65 fathoms) between 19th and 22nd May, 268 belonged to this group, and ranged in size from 25.2cm. to 41.2cm. (9 $\frac{1}{8}$ -16 $\frac{1}{4}$  inches), by far the greater proportion measuring 31cm. to 34cm. (12 $\frac{1}{4}$ -13 $\frac{3}{8}$  inches), and the mean being approximately 32.5cm., or 12 $\frac{3}{4}$  inches, the arithmetic average being a little higher, viz., 32.7cm. (fig. 5, pl. XII.).

Looking to these averages and the averages in January and December, it appears that the cod on the east coast of Scotland when two years of age measures, on the average, a little over 12 inches in length, probably 12 $\frac{1}{4}$ -12 $\frac{1}{2}$  (31cm. to 32cm.); the range of sizes may be placed at from about 9 to over 16 inches.

In the third year of life, after it has attained the size mentioned, growth is again rapid in the summer. I have referred to the size in May, when the fish are about thirteen months old.

At Sinclair Bay, on the coast of Caithness, on 4th June, 20 specimens measured from 26.6cm. to 36.3cm. (16-22 $\frac{1}{4}$  inches) when they were about 2 years and 2 months old.

At the "Doghole," off Aberdeen, on 30th July, 26 measured from 29.3cm. to 46cm. ( $11\frac{2}{3}$ – $18\frac{1}{2}$  inches); on 21st August, 12 ranged from 36.4cm. to 48.7cm. ( $14\frac{1}{4}$ – $19\frac{1}{2}$  inches); on 3rd September, 8 taken at the "Doghole" were from 39.4cm. to 45cm. ( $15\frac{1}{2}$ – $17\frac{3}{4}$  inches); 5 on 31st October measured from 39.5cm. to 53.5cm. ( $15\frac{1}{2}$ – $21\frac{1}{4}$  inches); 5 on 5th November were from 46.4cm. to 52cm. ( $18\frac{1}{4}$ – $20\frac{1}{2}$  inches); and on 28th and 29th November, 33 measured from 39.2cm. to 57.3cm. ( $15\frac{1}{4}$ – $22\frac{1}{4}$  inches). On 12th December, 35 measured from 43.7cm. to 61.6cm. ( $17\frac{1}{4}$ – $24\frac{1}{4}$  inches), the mean size being calculated at 49.5cm., or  $19\frac{1}{2}$  inches, and the age at 32 or 33 months.

Comparatively few were taken in the Moray Firth. On 12th November 16 ranged from 44.8cm. to 61cm. ( $17\frac{5}{8}$ – $24$  inches); on 19th December, 15 were from 46cm. to 60cm. ( $18$ – $23\frac{1}{4}$  inches); on 20th to 25th December, 40 measured from 40.3 to 59.8cm. ( $15\frac{3}{8}$ – $23\frac{1}{2}$  inches); on 17th January, off Dunbeath, 41 measured from 41.9cm. to 62.5cm. ( $16\frac{1}{2}$ – $24\frac{5}{8}$  inches).

In May, off the Shetlands, when they had begun their fourth year, 141 measured from 41.8cm. to 61.6cm. ( $16$ – $24\frac{1}{4}$  inches). The mean in this case is about 50cm., and the arithmetical average 50.9cm., or exactly 20 inches.

The average size of the cod on the east coast of Scotland when three years old may be placed at from between 19 and 20 inches, and the probable range of sizes from about 16 to about 24 inches.

The number of cod older than this in the collections was very small, and their distinction into groups problematical. In the haul on 12th November, in the Dornoch Firth, I have placed ten, measuring from 66.4cm. to 76cm. ( $25\frac{1}{2}$ – $30$  inches), as approaching their fourth year. And on 20–25th December, in Burghead Bay, six measured from 61.2cm. to 73.4cm. ( $24$ – $28\frac{1}{2}$  inches), which are assumed to be about the same age.

It is now desirable to compare the differences in the average length of the different groups, which represents the extent of the growth in a year from one annual series to the next. Considering first the means of the first and second series, as given in the Table, there are twelve cases in which this comparison can be made. The difference between the means varies in different collections from 14.5cm. to 19cm., and the average amounts to 16.57cm., or  $6\frac{1}{2}$  inches. Some are better than others, and if we select the nine cases in which the number of fishes in either of the series does not fall below 20, we find that the variation is from 14.5cm. to 18.5cm., and the average of the lot is 16.2cm., or  $6\frac{3}{8}$  inches. If the comparison is limited to the cases in which more than 70 fishes are represented in each series, and the numbers are fairly equal—and these cases are three in number—the differences are respectively 15cm., 15.5cm., and 15cm., the average being 15.2cm., or almost exactly 6 inches.

There is another method by which comparison of the differences between the groups can be made, viz., by comparing the difference between the sizes at which the maximum numbers of fishes occur—between the maximum ordinates, "modes," or apex, of each curve. As might be expected from these collections, which contain only moderate numbers of fishes, the members of any given group are not duly represented throughout; in some instances the larger fishes predominate in numbers, in others the smaller, and so on; and thus in a single collection of this kind comparison of the modes or maximum ordinates of two groups may be far from showing the true differences between these groups. Thus, in the fourteen cases in which such comparison can be made between the cod in their first year and those in their second year, the distance between the maximum ordinates varies from 11cm. to 22cm., or exactly double. The mean of these numbers,

however, is 16.5cm., or very nearly the figure derived from the comparison of the mean sizes; and if the average be made of all the instances, the figure is 16.1cm., or  $6\frac{3}{8}$  inches. If the collections are selected according to the numbers of fishes they contain, as above described in dealing with the approximate means, we get in the nine cases an average of 15.33cm., or a trifle over 6 inches. It seems very probable, then, that the cod on the east coast of Scotland increases in length at this early period of its life by from 6 to  $6\frac{1}{2}$  inches in the course of a year, and it is likely to be nearer the former figure than the latter. The particulars of the computation in the nine cases referred to are given in the accompanying Table:—

Month.	Number of Fish.		Difference between the Approximate Means.	Difference between the Modes or Maximum Ordinates.
	1st Series.	2nd Series.		
			Cm.	Cm.
September, . . .	42	167	15.5	16
October, . . .	75	37	16.5	14
November, . . .	301	20	18.5	19
" . . .	38	178	18	21
" . . .	78	113	15	13
December, . . .	91	179	15.5	11
July, . . .	29	77	17	15
August, . . .	90	93	15	14
" . . .	46	47	14.5	15
			16.2	15.33

In my previous paper, in which I dealt with the growth of the cod, the number of collections as well as the number of fishes was much less; but in the ten cases where comparison was possible the mean difference between the arithmetic averages of the two series (the method then made use of) was 16.7 cm., and in the five instances with the greatest numbers of fish it was 16.0cm., or  $6\frac{1}{4}$  inches.

With regard to the difference between the second and third groups, the collections in which this can be determined are much less numerous. The five cases are as follows:—

Month.	Number of Fish.		Difference between the Approximate Means.	Difference between the Modes or Maximum Ordinates.
	1st Series.	2nd Series.		
			Cm.	Cm.
November, . . .	178	33	16	-
December, . . .	41	15	16	16
" . . .	179	40	17.5	-
January, . . .	280	41	18.5	-
May, . . .	268	141	18	17.5
			17	16.7

The last collection (May) represents fish a little over two and three years of age. In my last paper there was only one instance in which comparison between these groups could be made, and the difference (arithmetical averages) was 18.2cm.; when incorporated with the others given above the average remains 17cm., or  $6\frac{1}{4}$  inches.

It is very desirable that complete observations should be made with exactitude as to the average size, and the limits of size, at which the cod becomes mature for the first time. Until this be done it is not possible to be quite certain as to the age at which reproduction begins. It is certainly not before four years, and it may be five years, of age.

HADDOCK (*Gadus aeglefinus*).

The number of haddocks measured was 6682, making, with those whose measurements are dealt with in the two previous papers referred to, a total of 28,760 specimens of this species. The collections were partly from Aberdeen Bay and neighbourhood and partly from the Moray Firth; the measurements in one-centimetre grouping are given in the appended Table XXII.

A collection made on 15th January 1902 at the "Doghole," off Aberdeen, in 57 fathoms, 802 haddocks, most of them belonging to the first group, or fish of the previous spawning. These numbered 775, measuring from 150mm. to 210mm. ( $5\frac{3}{8}$ – $8\frac{1}{4}$  inches); most were aggregated between 16cm. and 19cm., the apex of the curve formed by the measurements being at 17·5, which was also the mean, while the arithmetic average was 180·5. The second group was represented by only a few fish, from 240mm. to 324mm., or near it, and the computed average size was 286·8mm., or about  $11\frac{5}{8}$  inches, the annual increment being thus about  $4\frac{3}{4}$  inches.

On 13th May, in the same year, another lot of 596 haddocks was taken on the same ground, in 52 fathoms, most of them belonging to the first group, now over one year of age. They measured from 145mm. to 239mm. ( $5\frac{3}{4}$ – $9\frac{3}{8}$  inches); most were between 17cm. and 22cm., the apex of the curve was at 19·5cm., and the mean was the same (nearly  $7\frac{1}{2}$  inches). The growth in the interval of about 118 days was thus approximately 2cm., or  $\frac{2}{3}$  of an inch. The second group was represented by only a few fishes, from about 25cm. to 32cm., or more.

On 31st October 1903 a large collection of 1249 haddocks was obtained in Aberdeen Bay, in 8–12 fathoms, and the measurements are of some interest, as three groups at least are well represented, and a considerable number of them—all those above 27cm., and many below that size—were differentiated according to sex (fig. 7A, pl. XII.). It may be said at once that, contrary to the rule among flatfishes, the males and females are of approximately the same size, and thus grow at the same rate, though the females are in excess as to numbers. The first group, that is to say, haddocks approximately seven months old, ranged in length from 136mm. to 207mm. ( $5\frac{3}{8}$ – $8\frac{3}{8}$  inches), most being between 14cm. and 19cm.; the mode was at 16cm., and the mean at 16·5cm., or  $6\frac{1}{2}$  inches.

The second group extended from 217mm. to 310mm. ( $8\frac{1}{2}$ – $12\frac{1}{4}$  inches); most measured from 25cm. to 30cm., the apex of the curve was at 27cm., and the mean was 27·5cm., or a little above  $10\frac{3}{4}$  inches. The division between this group and the third group is very distinct in curves made on ·5cm. grouping, at 31cm., and it is the same for the males as for the females. These fish were about one year and seven months old.

The third group extended from 31cm. to about 38cm., the bulk of the haddocks were between 32cm. and 35cm., the mode is at 33cm., and the mean is 33·5cm., or  $13\frac{1}{4}$  inches. This group is partly fused with the last, and it is to be noticed that in the ·5cm. curves there is a slight depression at 34cm., both with regard to the males and the females, suggestive of two groups.

The means of the three groups, taking the last provisionally as one, are thus as follows:—

[TABLE.

	Age.	Mean Size.		Approximate Annual Growth Indicated.	
		Cm.	Inches.	Cm.	Inches.
1st	7 months.	16.5	6½	-	-
2nd	1 year and 7 months.	27.5	10¾	11	4½
3rd	2 years and 7 months.	33.5	13¼	6	2½

The third group will constitute the great spawning shoal in the following spring.

On 29th December in the same year, 162 haddocks, taken in Aberdeen Bay, showed the presence of three groups. The first extended from 146mm. to 215mm., or near it (5¾-8½ inches); most were between 15cm. and a little over 19cm., the apex of the curve was at 17.5cm., and the mean was about 17.2cm., or 6¾ inches. The number is not large, but the measurements show an increase in length of about 1cm. from 31st October. The other groups are but slightly represented; one appeared to extend from 23cm. to 30cm., and the other from the latter to 36cm.; there were also 7 haddocks from 40cm. to 43cm. (15¾-17 inches), probably approaching their fourth year.

A collection made with the small-meshed net on 29th March, 1905, numbered 314, and belonged to the first group. It extended from 133mm. to 204mm. (5¼-8 inches); most were between 15cm. and 18.5cm., the apex of the curve was at 17cm. and the mean about 16.5cm. or 6½ inches. A few small haddocks belonging to this haul were, omitted to be measured.

Four collections of haddocks from Smith Bank, in the Moray Firth, were measured, the depth in which they were taken being usually 22 or 23 fathoms.

On 1st April, 1904, they numbered 885, and three groups were represented, the first only by a few fish from 15.8cm. to 20cm. or 21cm. The second series was well shown; it extended from 20cm. or 21cm. to 29cm. (8-11½ inches); most measured between 23cm. and 27.5cm., the apex of the curve constructed on the measurements was at 25cm., and the mean was 25.2cm. or 25.3cm. (10 inches). These haddocks were about two years of age.

The next group extended from 29cm. to about 37cm. (11½-14½ inches), most of them were between 30cm. and 34cm. (11¼-13½ inches), the apex of the curve was at 31cm., and the mean was about 32cm., or 12½ inches. These fish were about three years of age. The particulars are these:—

	Age.	Average Size.		Apparent Annual Growth.	
		Cm.	Inches.	Cm.	Inches.
1st	1 year old.	-	-	-	-
2nd	2 years old.	25.2	10	-	-
3rd	3 years old.	32	12½	6.5	2½

On 23rd October, 1903, 306 haddocks were obtained on Smith Bank, representing three groups, but only the second was at all well indicated. The first group consisted of 8 haddocks from 115mm. to 204mm. The second group extended from 21cm. to 28cm. or 29cm.; most of them were between 22.5cm. and 26cm. ( $8\frac{3}{4}$ – $10\frac{1}{4}$  inches), the apex of the curve was at 25cm., and the mean was about 24.3cm., or  $9\frac{1}{2}$  inches. The rest of the haddocks were insufficient to indicate the limits or average size of the next group. One haddock measured 49cm. ( $19\frac{1}{4}$  inches) (fig. 7B, pl. XII.).

Another collection of 62 haddocks, on 14th November, 1903, also contained members of three groups, but only the second was of value as regards the rate of growth. It extended from 24.7cm. to 33cm. or 34cm. ( $9\frac{3}{4}$ –13 inches); most were aggregated between 29cm. and 32cm., the apex of the curve was at 30cm., and the mean was about 28.5cm., or  $11\frac{1}{4}$  inches. There was one haddock at 52cm. ( $20\frac{1}{2}$  inches).

A collection of 756 haddocks on 12th December, 1904, belonged to the first group, all but one. It extended from 137mm. to 208mm. ( $5\frac{3}{8}$ – $8\frac{1}{4}$  inches); most measured between 15cm. and 18.5cm. ( $5\frac{3}{8}$ – $7\frac{1}{2}$  inches); the apex of the curve was at 16.5cm., and the mean was 16.7cm., or  $6\frac{5}{8}$  inches.

Other collections of haddocks obtained in the Moray Firth, off Burghead, Kinnaird Head, Lybster, and the Dornoch Firth were measured.

Those obtained in the Dornoch Firth are small in number, haddocks usually not being caught there in any quantity.

On 22nd October, 1903, 95 haddocks belonging to three or four annual series were measured, but none of the groups are well indicated. The first contained 7 haddocks, from 109mm. to 153mm. The second contained most of the fish, but its limits are not very clear. The smallest was 24.2cm.; most were between 26cm. and 28cm. ( $10\frac{1}{4}$ – $10\frac{3}{8}$  inches); the apex of the curve was at 27cm., and the group apparently terminated about 31cm. or 32cm. (fig. 7B, pl. XII.).

In a haul on 13th November, the first and second series were represented by 22 haddocks, and in another, on the 27th December, 42 haddocks were taken, mostly belonging to the third series.

At Burghead Bay, on 20th October, 1903, 248 haddocks mostly belonged to the second series. The first group was represented by 30 haddocks, measuring from 105mm. to 165mm. ( $4\frac{1}{8}$ – $6\frac{1}{2}$  inches); the apex of the curve was at 12cm., and the mean about 12.5cm., or  $4\frac{7}{8}$  inches. The second series extended from 23.1cm. to about 30cm.; most measured between 25cm. and 27cm. ( $9\frac{7}{8}$ – $10\frac{3}{8}$  inches); the apex was at 26cm., and the mean about 25.5cm., or 10 inches (fig. 7B, pl. XII.).

In a collection made on 29th December, 1903, 138 haddocks were obtained belonging to several groups. The first included 9 haddocks, from 150mm. to 206mm. The second group extended from 23.2cm. to about 30cm. ( $9\frac{1}{4}$ – $11\frac{3}{4}$  inches), most ranging between 24cm. and 28cm.; the apex of the curve was at 27cm., and the mean was about 26cm., or  $10\frac{1}{4}$  inches. The rest of the haddocks were few in number. There were three very large ones, measuring respectively 60cm. ( $23\frac{3}{4}$  inches), 73.6cm. ( $29\frac{1}{2}$  inches), and 74cm. ( $29\frac{1}{4}$  inches).

A haul on the witch ground off Kinnaird Head, in from 40 to 50 fathoms, on 23rd January, 1904, yielded 199 haddocks belonging to several series. The first ranged from 14.3cm. to 18.8cm. ( $5\frac{5}{8}$ – $7\frac{3}{8}$  inches), most being between 14.5cm. and 17cm.; the apex of the curve, or the greatest number in the series, was at 16cm., and the mean was about 15.8cm., or  $6\frac{1}{4}$  inches.

The second group extended from 21.2cm. to a point not easy to determine; most of the haddocks measured from 22cm. to 27cm., the apex of



the curve was at 25cm. The third group consisted of a few specimens, mostly between 32cm. and 35cm. ( $12\frac{5}{8}$ – $13\frac{3}{4}$  inches), and apparently extending to about 40cm., and no doubt represented the spawning shoal.

A collection off Lybster, on the coast of Caithness, on 22nd October, 1903, yielded a number of various groups. The small-meshed net around the cod-end was ruptured, and only contained 4 haddocks. The first series was represented by 4 fishes, 12cm. and 13cm. The second group extended from 21.4cm to 29cm. ( $8\frac{1}{2}$ – $11\frac{1}{2}$  inches); most were between 25cm. and 27cm., the apex of the curve was at 26cm., and the mean was about 26.5cm., or  $10\frac{1}{2}$  inches. The smaller members of the group were not present in normal numbers.

The next group extended from about 29cm., apparently, to 36cm. ( $11\frac{1}{2}$ – $14\frac{1}{8}$  inches); most were aggregated between 31cm. and 34cm., the apex of the curve was at 32cm., and the mean was about 32.5cm., or  $12\frac{3}{4}$  inches.

It may be noted that in the curve of this group, as in the curves for the collection from Aberdeen Bay on 31st October, and for the collection from Smith Bank on 1st April, the descending slope is interrupted, suggestive of a division. It is better shown in 5cm., as below:—

	Cm.	32	32.5	33	33.5	34	34.5	35	35.5	36	36.5
31st October,	♀	22	24	27	29	20	27	31	16	18	9
	♂	7	7	10	16	10	16	7	6	4	8
	Cm.	29	31	37	45	30	43	38	22	22	17
1st April . . .		33	24	22	22	28	20	12	8	7	5
22nd October . .		34	52	33	44	37	40	25	23	3	7

At this size (reproductive) growth is slower and the fusion of the groups greater, and it is quite likely that the division indicated is a real one.

### WHITING (*Gadus merlangus*).

Twenty-one collections of whittings were measured, most of them taken in the Moray Firth, the number being 8346, which, with those contained in my previous papers, makes about 58,000 of this species measured. The results as regards growth are confirmatory of the conclusions previously reached, and the collections may be briefly referred to.

Six collections were obtained from the Dornoch Firth, as shown in Table XXIII. The first was on 22nd October, 1903, and it comprised 233 whittings, taken in from 6 or 7 to 13 fathoms. The smallest was 51mm. (2 inches), and the largest of the first series, to which almost all the specimens belonged, was apparently 176mm. ( $7\frac{3}{8}$  inches). The great majority of the fishes were aggregated between 9cm. and 13cm., the apex of the curve, or point of greatest aggregation, being 11cm., which was also the mean between the limits named; the arithmetical average was about 105.6mm. The average size of these whittings was thus about  $4\frac{1}{4}$  inches. Two specimens of 21cm. and 22cm. probably represent a second series, and there is a third at 36cm.

The next collection, on 11th November, comprised 421 whittings, all but one (at 27cm.) apparently belonging to the same series. The smallest measured 58mm. ( $2\frac{1}{4}$  inches) and the largest 194mm. ( $7\frac{5}{8}$  inches); most were aggregated between 10cm. and 14cm., the apex of the curve being at 12cm., which was also the mean, while the computed average was approximately 120.5cm. ( $4\frac{3}{4}$  inches).

On 27th December, 1903, a collection of 494 whittings belonged almost entirely to the first series. Most were aggregated between 11cm. and 16cm.; the apex of the curve was 13cm., and the mean about 13.5cm., or about  $5\frac{1}{4}$  inches. The smallest of the group measured 85mm. ( $3\frac{3}{8}$  inches) and the largest probably 211mm., but it may have been less.

The next collection was on the 28th December. It comprised 1209 whittings from the small meshed net only, the whittings obtained in the trawl net having been omitted from measurement. The smallest was 76mm. (3 inches) and the largest 177mm.; most were aggregated between 10cm. and 13cm., the apex being at 12cm. and the mean at 11.5cm., or about  $4\frac{1}{2}$  inches. The low average is due to the omission referred to.

Another collection, on 7th December, 1904, included 496 whittings, the smallest being 79mm. ( $3\frac{1}{8}$  inches) and the largest 183mm. ( $7\frac{1}{4}$  inches). Most were aggregated between 12cm. and 15cm., the mean being 13.5cm., or  $5\frac{3}{8}$  inches.

The sixth collection from the Dornoch Firth was on 9th February, 1905, and contained 628 whittings. Nearly all belonged to the first group, now approaching one year of age, and the bulk of the specimens were aggregated between 11cm. and 15.5cm., the average being 13.2cm., or  $5\frac{1}{4}$  inches.

On the south coast of the Moray Firth, at Burghead Bay and in that neighbourhood, another series of collections of whittings was made, and in most of these cases two groups were represented. The first was on 20th October, 1903; it comprised only 94 whittings, 47 belonging to each series, and the numbers are thus small. In the first group the smallest whiting was 75mm. (almost 3 inches), the largest being 146mm., and the mean about 10.5cm. ( $4\frac{1}{8}$  inches). In the second group the smallest was 182mm. ( $7\frac{1}{8}$  inches), and the largest apparently 299mm., or  $11\frac{3}{8}$  inches; the mean size was about 23.5cm., or  $9\frac{1}{4}$  inches. The curves for the measurements are a little irregular, but, so far as they go, they show a difference between the two groups, both between the actual apices of the curves (or modes) and the means, of about 13cm., or  $5\frac{1}{8}$  inches.

The second collection, on 14th November, 1903, comprised 355 whittings, mostly of the two first groups referred to. The younger group contained 193 whittings measuring from 61mm. to 174mm. ( $3\frac{1}{4}$ – $6\frac{5}{8}$  inches); most were aggregated between 10cm. and 14cm., the apex being at 13cm.; the mean about 12cm. ( $4\frac{3}{4}$  inches), and the arithmetic average 121.8cm. The curve of the second group is less regular, the apex is at 28cm., and the mean about 27.5cm. ( $10\frac{3}{4}$  inches). The difference is 15cm. and 15.5cm., or  $5\frac{3}{8}$  inches. These whittings were taken further off the shore, in water of 30 fathoms depth.

In a collection made on 28th December, 1903, in the same locality, in water of 30 fathoms, comprising 386 whittings, the first group, which included most of them, ranged from 75mm. to 185mm. ( $3$ – $7\frac{1}{4}$  inches). The great majority were aggregated between 11cm. and 15cm., the apex of the curve was at 13cm., or  $5\frac{1}{8}$  inches, and this was also the mean, while the arithmetic average was 129mm.; the second group were represented by only a few, insufficient to show the limits or average size.

Another small collection of 29 whittings was obtained on 29th December, the first group ranging from 110cm. to 184cm.

A collection on 23rd January, 1904, in 50 fathoms, off Kinnaird Head, numbered 131, and chiefly belonged to the first group. This group ranged in size from 76mm. to 165mm. Most were aggregated between 10cm. and 13.5cm., the apex of the curve being at 12cm., and the mean a little less; the arithmetic average was 120.7mm. The second group included few fishes, most being at 24cm. to 37cm.

At Findhorn, in the same neighbourhood, a collection of 293 was taken on 1st April, 1904, in 30 to 32 fathoms. They belonged for the most part to the second group, the sizes extending from 177mm. (7 inches) to about 30cm. or 31cm.; most were between 22cm. and 28cm., the mean and average being at 25cm. ( $9\frac{1}{8}$  inches). They represent whittings at nearly two years of age.

Other collections were made on Smith Bank, in the Moray Firth, usually in 22 or 23 fathoms of water. The first of these was on 23rd October, 1903, when 420 whittings were taken, two groups being represented. The smaller, or fish spawned in the same year, ranged from 87mm. to 160mm. ( $3\frac{1}{2}$ — $6\frac{3}{8}$  inches); most measured between 11cm. and 13cm.; the mean was 12cm., and the arithmetic average 128mm., or a trifle over 5 inches. The second series, which included 221 fishes, ranging from 200mm. to 292mm., were mostly between 20cm. and 24.5cm.; the apex of the curve was at 22cm., and the arithmetic average was 233mm., or a trifle over  $9\frac{1}{8}$  inches. From apex to apex of the two groups, the distance is 10cm., or 4 inches; the difference between the arithmetic averages is 10.5cm., or  $4\frac{1}{4}$  inches.

On 27th December, 1903, 147 whittings taken in the same locality were measured, two groups being represented. The first extended from 113mm. to 181mm., most being aggregated under 13cm. The second group extended from 207mm. to, apparently, 305mm., most being aggregated between 23cm. and 25cm. The numbers are too few, and the curves formed on the measurements too irregular, to enable any satisfactory comparison to be made between the two groups in this case.

Another collection of 955 whittings at Smith Bank, on 1st April, 1904, was represented almost entirely by one group, the second. It extended from 19cm. or 20cm. to 30cm. or 31cm. or 32cm.; most were aggregated between 22cm. and 26cm., the greatest number being under 23cm., and the mean size was about 24.5cm., or  $9\frac{1}{8}$  inches. These fish were nearing their second year of age.

A small collection of 124 whittings taken in the same locality on 12th December, 1904, was limited almost entirely to the first group. It contained one whiting of 75mm. (3 inches), the next measuring 110mm., and the small fish were thus imperfectly represented. Most were aggregated between 13cm. and 16cm.

A few collections of whittings taken in Aberdeen Bay and neighbourhood were also measured. In one, on 13th May, at the "Doghole," or deep depression lying a few miles off the coast, in 55 fathoms, the 275 fish belonged mostly to the second group, the first being imperfectly indicated. The smallest whiting taken measured 115mm., or  $4\frac{1}{2}$  inches. The majority were between 19cm. and 26cm., most being at 22cm., and the mean size was 22.5cm. or  $8\frac{7}{8}$  inches.

In a collection of 148, on 11th February, 1905, in Aberdeen Bay, the smallest measured 76mm. The greatest number were between 11cm. and 14cm., most being at 13cm. ( $5\frac{1}{8}$  inches), and the mean was a trifle higher.

On 29th March following 362 whittings were measured which belonged to the first group. The smallest measured 110cm. The greater number measured between 13cm. and 15cm. The apex of the curve of measurements was at 14cm. ( $5\frac{1}{2}$  inches), and the mean was a trifle above this. These were approaching one year of age.

In a haul on 31st October, 1903, 701 whittings were obtained. In the first group the smallest whiting was 56mm. ( $2\frac{1}{4}$  inches), and the largest 181mm., or thereabout. As in some other cases in autumn, the smaller fish formed a little semi-isolated group, suggesting a series of younger fishes, the .5cm. grouping being as follows :—

5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5
5	4	5	4	5	1	2	1	4	2	14	21	29 &c.

As I pointed out in my previous papers, these very young whittings have been leading a pelagic life, and now descend to the bottom when the seasonal change of temperature makes the water there warmer than the surface layers.

Most of the fishes in this series were aggregated between 10cm. and 16cm., the apex being at 13cm., as well as the mean, and the arithmetic average was 132mm., or nearly  $5\frac{1}{4}$  inches. The grouping of the larger whittings is not very clear, but most of them measured from 21cm. to 30cm., the mean being about 25.5cm., or 10 inches, a difference of about 12.5cm., or about  $4\frac{7}{8}$  inches from the average of the younger group.

In a collection made on 29th December, 1903, 498 whittings were obtained, nearly all belonging to the first group. Their sizes ranged from 115mm. to 180mm.; most were between 12cm. and 16cm., the greater number, or the apex of the curve, being 14cm. ( $5\frac{1}{2}$  inches), which was also the mean.

The principal results in regard to the growth of the first group may be tabulated as follows:—

	Date.	Average Size.		Smallest Size.		Largest Size.	
		Cm.	Inches	Cm.	Inches	Cm.	Inches
Dornoch Firth,	22nd October, .	11	$4\frac{3}{8}$	5.1	2	17.6	$7\frac{1}{8}$
Do., . . .	11th November,	12	$4\frac{3}{4}$	5.8	$2\frac{1}{4}$	19.4	$7\frac{7}{8}$
Do., . . .	27th December,	13	$5\frac{1}{4}$	8.5	$3\frac{3}{8}$	21.1	$8\frac{1}{4}$
Do., . . .	7th December,	13.5	$5\frac{3}{8}$				
Burghead, .	20th October, .	10.5	$4\frac{1}{8}$	7.5	3	14.6	$5\frac{3}{4}$
Do., . . .	14th November	12	$4\frac{7}{8}$	8.1	$3\frac{1}{4}$	17.4	$6\frac{7}{8}$
Do., . . .	28th December,	13	$5\frac{1}{8}$	7.5	3	18.5	$7\frac{1}{4}$
Off Kinnaid, .	23rd January, .	12	$4\frac{7}{8}$	7.6	3	16.5	$6\frac{1}{2}$
Smith Bank, .	23rd October, .	12.3	$4\frac{7}{8}$	8.7	$3\frac{1}{2}$	16.0	$6\frac{3}{4}$
Aberdeen Bay,	11th February,	13	$5\frac{1}{8}$	7.6	3		
Do., . . .	29th March, .	14	$5\frac{5}{8}$	11.0	$4\frac{3}{8}$		
Do., . . .	31st October, .	13	$5\frac{1}{4}$	5.6	$2\frac{1}{4}$	18.1	$7\frac{1}{4}$
Do., . . .	29th December,	14	$5\frac{5}{8}$	11.5	$4\frac{1}{2}$	18.0	$7\frac{1}{8}$

The mean sizes of the second group of whittings varied as follows:—Burghead—20th October, 23.5cm., or  $9\frac{1}{4}$  inches; 14th November, 27.5cm., or  $10\frac{3}{4}$  inches. Smith Bank—1st April, 24.5cm., or  $9\frac{5}{8}$  inches. Aberdeen Bay—13th May, 22.5cm., or  $8\frac{7}{8}$  inches; 31st October, 22.5cm., or 10 inches.

#### GREY OR COMMON GURNARD (*Trigla gurnardus*).

The number of specimens of the grey gurnard measured in connection with the observations in this paper was 5495, belonging to about 50 collections.

Another paper in which the growth of this fish is dealt with was published in the *Seventeenth Annual Report*.\*

The spawning period of the gurnard is prolonged, extending from April to the latter part of August, and into September, or, according to Heincke and Ehrenbaum, to October; spawning is at its height in the early part of June. In May the duration of "incubation" is eight or ten days, but in

\* "On the Migratory Movements and Rate of Growth of the Grey or Common Gurnard," Part III., p. 210.

June and July it is shorter, so that one may look to the period when the swarms of young gurnards appear as about the middle of June or a little later.

The gurnard reaches maturity at a minimum length of about 8 to 8½ inches, say, 20cm. to 22cm. Thus, in 201 which were fully mature, the smallest of the 17 males which were ripe measured 11 inches, and the smallest of the 184 females was 8½ inches. Of 49 males which were nearly mature the smallest was 9 inches, and of 273 females of the same class the smallest was 8½ inches.

Among 601 gurnards which were about half to three-parts mature, the smallest of the 172 males was 7½ inches, and the smallest of the 429 females was 8 inches.

While gurnards may be mature at the sizes stated, it must be remembered that they are the minimum sizes, and represent only the smallest fishes of the group which first reaches maturity. They may spawn in their third year, as I stated in my former paper as the probable age of first-maturity, but it is possible that they may not spawn till a year later, at least the female fishes, when the average size is somewhat larger.

Owing to the unusually prolonged spawning season, and the fact that it begins at a time when the temperature of the water has commenced to rise and ends when the temperature has fallen, one might expect that the young gurnards from the same spawning will show much difference in size.

Those which have been hatched at the commencement of the season, say in April or early in May, meet with a rising temperature and have the whole of the summer, the period most favourable for growth; while those hatched in September or October meet with a rapidly falling temperature and the winter period, which is as a rule unfavourable to growth.

Thus we find in September, in the tow-nets, gurnards as small as 5mm. to 6mm., that is to say, not very long hatched, and in October they may be 12mm. and 20mm.

I have made a Table of the post-larval and young gurnards obtained over a series of years, both in tow-nets and small-meshed trawl nets, which is appended. Almost all below about 30mm. were got by tow-nets, and most of those larger by the trawls. The places from which the collections came were Aberdeen Bay (A.), the Moray Firth (M.F.), Firth of Forth (F.), the Clyde (C.).

|TABLE.

## GURNARD.

Mm.	August.				September.			October.				November.			Dec.	Feb.			May.	Summary.					
	I.	II.	III.	IV.	I.	II.	III.	I.	II.	III.	IV.	I.	II.	III.	I.	I.	II.	I.	August.	September.	October.	November.	December.	February.	
	MF. 8-26	A. 25	C. 24	F. 29	MF. 2	A. 1-25	MF. 21	A. 8-13	C. 10	MF. 29	F. 29	MF. 8-11	C. 26	A. 18-21	MF. 7-27	A. 11	MF. 9								
5-6	10	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	10	1	..	..	..	..	
7-8	11	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	11	..	..	..	..	..	
9-10	4	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	4	12	..	..	..	..	
11-12	1	..	..	..	..	..	2	..	..	1	..	..	..	..	..	..	..	..	12	12	1	..	..	..	
13-14	2	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	
15-16	1	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	..	..	..	
17-18	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
19-20	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	12	..	..	..	..	..	
21-22	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	12	..	..	..	
23-24	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	12	..	..	..	
25-26	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..	..	
27-28	..	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	12	..	..	..	
29-30	..	..	..	..	..	..	..	2	..	..	1	..	..	..	..	..	..	..	..	..	3	..	..	..	
31-32	..	1	..	..	1	2	..	3	..	..	..	..	..	..	..	..	..	..	1	3	3	..	..	..	
33-34	..	1	..	..	..	1	..	2	..	..	..	..	..	..	..	..	..	..	1	1	12	..	..	..	
35-36	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	
37-38	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
39-40	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	
41-42	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	
43-44	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
45-46	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	1	..	..	
47-48	..	..	..	..	..	2	..	..	..	..	..	..	..	1	..	..	..	..	..	2	..	1	..	..	
49-50	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
51-52	..	..	..	..	..	3	..	1	..	..	..	1	1	..	1	..	..	..	..	3	1	2	1	..	
53-54	..	..	..	..	..	3	..	..	..	..	..	1	..	..	1	..	..	..	..	3	..	1	1	..	
55-56	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	
57-58	..	..	..	..	..	2	..	2	..	..	..	..	..	1	..	..	..	..	..	2	2	..	1	..	
59-60	..	..	..	..	..	1	..	1	..	..	..	1	..	..	..	..	..	..	..	1	1	1	..	..	
61-62	..	..	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	1	1	..	..	..	
63-64	..	..	..	..	..	1	..	1	..	..	..	2	..	1	..	..	..	..	..	1	1	3	..	..	
65-66	..	..	..	..	..	..	..	1	..	..	..	2	..	1	..	..	..	..	..	..	1	3	..	..	
67-68	..	..	..	..	..	1	..	2	..	..	..	3	..	..	..	2	..	..	..	1	2	3	..	2	
69-70	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	1	..	..	..	..	1	..	1	..	
71-72	..	..	..	..	..	1	..	1	1	1	..	1	..	..	..	..	..	..	..	1	3	1	..	..	
73-74	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	1	..	..	..	..	1	1	1	
75-76	..	..	..	..	..	..	..	..	..	..	..	5	..	..	2	..	..	..	..	..	..	5	2	..	
77-78	..	..	..	..	..	..	..	2	..	..	..	3	..	..	1	..	2	..	..	..	2	3	1	1	
79-80	..	..	..	..	..	..	..	2	1	..	..	7	..	..	..	..	..	2	..	..	3	7	..	..	
81-82	..	..	..	..	..	..	..	..	..	..	..	7	..	..	4	..	..	..	..	..	..	7	4	..	
83-84	..	..	..	..	..	..	..	..	..	..	..	12	..	..	1	1	..	2	..	..	..	12	1	1	

In this Table it will be noticed, especially in the columns in which the various collections in each month are summed up, that these small gurnards were got only in certain months, viz., August, September, October, November, December, February, and May. None under 5cm. were got in November, and none under 4·5cm. in December, while in February the smallest was 6·7cm., and in May 7·9cm. They do not appear in the collections before August, and the Table shows that their growth at this stage is fairly rapid.

In my former paper I gave a Table of all the small gurnards under 3 inches which were obtained by the fine-meshed trawl-nets of the "Garland," arranged according to months, and it may be summarised here. None under 3 inches (7·6cm) were caught between May and September—a fact also borne out by the above Table—and the greater number were obtained in October and September. The absence of the small gurnards was not due to hauls of the net not having been made in the intervening months, since 27 were made in June, July, and August. The number caught in each month in which hauls with the fine net were made, and the average number of gurnards under 3 inches taken per haul are given in the following Table:—

	Jan.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
Number of Hauls, .	12	41	34	10	6	11	23	25	13
Number of Gurnards under 3 in. (7·6cm.),	1	3	8	-	-	-	2	30	24
Average per Haul, .	0·08	0·07	0·23	0·0	0·0	0·0	0·09	1·2	1·8

The conclusion drawn from the facts was that those taken in January, April, and May belonged to the previous year, and that the absence of gurnards under 3 inches in June, July, and August was due to the growth in summer taking them above that size.

It was also concluded that the gurnards ranging about 6 inches (15cm.) in length in the spring were from 18 months to 2 years old; that the gurnard did not reach maturity until the third year; and that there appeared to be annual groups differing in length by about two inches from each other—the measurements having been in inches and fractions of an inch.

In the collections referred to in the present paper, the early groups are sometimes distinctly marked off from one another, and little difficulty has been experienced in determining the rate of growth of this fish.

It may be mentioned that the difficulty in regard to the prolonged spawning period, and the summer or winter season for the early and late larvæ to which reference has been made, is counteracted by a rather slow rate of growth on the part of this fish, and possibly by the growth in the winter not being retarded to the extent that is usual amongst other young fishes. In this respect the young gurnard offers a striking contrast to the young plaice or dab, which may be even shorter in early spring after passing through the cold winter months than they were at the onset of winter. In the latter case the habitat is in the shallow water, exposed to the changes in the air temperature and varying with it, whereas the gurnard is pre-eminently a migratory fish at all stages, and leaves the inshore waters for deeper water, where the temperature is higher, in autumn.

In my previous paper I showed that an extremely close relation existed between the changes of the temperature of the water and the abundance and migration of the gurnard, none of them entering the Firth of Forth until the temperature reached about 40·5° F. The average number of gurnards taken in that Firth per haul of the net in the various months of the year, and the mean bottom temperature, are as follows:—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Gurnards, .	·02	·04	·29	11·1	44·2	30·2	34·0	21·6	18·9	8·4	1·1	·2
Temperature,	42·2	40·6	40·0	42·2	45·6	47·6	50·8	53·5	53·3	51·4	48·1	44·8

On the other hand; in the Moray Firth and the Firth of Clyde, where there is deep water, the gurnards moved out into the deeper water. Here are the similar details for the deep-water stations in the Moray Firth and for the Clyde:—

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Moray Firth—												
Gurnards, .	—	—	—	—	21·0	19·2	23·1	37·3	—	39·4	29·6	—
Temperature,	—	—	—	—	45·5	47·7	50·2	52·1	—	52·6	49·4	—
Clyde—												
Gurnards, .	13·6	0·0	26·5	22·2	18·6	—	10·6	63·6	11·8	27	19	31·1

There are not complete observations in regard to the Clyde to enable the mean temperature to be given, but they show that in January at the deeper stations, where the gurnards were chiefly caught, the temperature is from 47–48 F., and in December it is about 6 F. higher than in the Firth of Forth at the same period.

It is thus to be inferred, from what is known in regard to the relation between the temperature of the water and the growth of fishes, that the young gurnards do not cease growing in winter, but that, migrating to regions where the winter temperature is high, they continue to grow and are found to be larger in spring. The explanation is necessary to account for the different groups in the collections.

In a number of Tables appended to this paper the collections of gurnards have been tabulated in one-centimetre groups, but in many cases the limits of the groups are much better brought out by a ·5cm. arrangement of the measurements, and some of these will now be given.

I have arranged in the following Table the measurements of certain collections from Aberdeen Bay, the Firth of Forth, and the Dornoch Firth, in ·5cm. up to 34cm. The columns refer to the collections, as follows:—

Col.	I. Aberdeen Bay, Summary of July collections.
"	II. " " " " September collections.
"	III. " " " " October collections.
"	IV. Dornoch Firth, Summary of November collections.
"	V. Burghhead Bay, " September collections.
"	VI. Firth of Forth, " May collections.
"	VII. " " " " July collections.



Col VIII. Firth of Forth, Summary of August collections.

" IX. Summary of all July collections.

" X. " " October collections.

" XI. " " November collections.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.
2	-	-	-	-	-	-	-	-	-	-	-
2-5	-	1	1	-	-	-	-	-	-	-	-
3	-	1	4	-	-	-	-	-	-	4	-
3-5	-	1	1	-	-	-	-	-	-	1	-
4	-	-	-	-	-	-	-	-	-	-	-
4-5	-	1	-	-	-	-	-	-	-	-	-
5	-	6	1	-	-	-	-	-	-	1	2
5-5	-	4	2	1	-	-	-	-	-	2	1
6	-	3	3	2	-	-	-	-	-	3	2
6-5	-	1	3	3	-	-	-	-	-	3	5
7	-	1	1	3	-	-	-	-	-	2	3
7-5	-	-	3	10	-	2	-	-	-	3	14
8	-	-	2	14	-	2	-	-	-	1	20
8-5	-	-	1	13	-	1	-	-	-	2	15
9	-	2	1	12	-	4	-	-	-	1	15
9-5	1	1	1	7	-	4	-	-	1	1	8
10	1	-	-	7	-	-	-	-	1	-	10
10-5	11	-	2	4	-	2	-	1	11	2	5
11	24	-	1	4	-	-	1	2	25	1	5
11-5	26	1	1	-	-	2	6	3	32	1	1
12	28	1	3	1	-	-	6	9	34	4	1
12-5	14	1	3	3	-	3	10	14	24	3	4
13	7	6	4	1	-	1	5	14	12	12	5
13-5	3	5	6	-	-	-	4	14	7	15	2
14	4	7	5	-	1	1	1	9	5	7	6
14-5	5	10	6	-	-	4	4	8	9	14	13
15	4	11	7	-	-	2	5	2	9	18	20
15-5	7	6	8	2	4	2	7	1	14	12	34
16	8	3	5	-	2	4	8	2	16	12	37
16-5	9	1	4	1	1	5	26	2	36	14	36
17	19	2	2	1	3	1	9	3	28	10	19
17-5	11	2	1	1	4	7	18	3	32	9	14
18	9	3	-	-	6	2	9	2	19	4	18
18-5	10	-	1	1	21	1	11	3	24	6	21
19	4	4	1	1	21	1	5	2	10	9	24
19-5	4	5	-	1	32	3	2	3	7	4	22
20	3	4	-	1	21	2	2	4	5	8	27
20-5	4	8	1	2	27	1	-	3	4	4	37
21	4	3	2	4	20	4	1	2	5	4	36
21-5	-	4	4	1	10	4	1	1	3	7	29
22	2	1	1	-	16	1	2	2	4	8	28
22-5	-	4	2	-	8	3	2	1	3	6	22
23	1	3	-	-	6	-	2	1	4	3	19
23-5	3	-	1	-	16	1	-	3	6	3	23
24	2	-	-	-	9	1	1	-	5	1	18
24-5	1	2	1	-	28	-	1	5	2	5	19
25	1	1	1	-	18	1	-	1	2	1	17
25-5	-	-	1	-	21	3	1	3	2	3	18
26	-	1	-	-	12	1	-	-	1	1	21
26-5	1	-	-	-	21	1	1	-	2	-	14
27	1	1	-	1	15	4	-	-	3	2	22
27-5	-	1	1	-	19	1	-	2	1	3	12
28	-	2	1	1	13	1	-	1	1	2	11
28-5	1	-	-	-	9	2	-	1	1	2	17
29	-	1	-	1	5	-	-	-	2	2	17
29-5	-	-	-	-	14	1	-	1	-	5	10
30	1	-	-	-	10	3	-	-	1	2	13
30-5	-	-	-	-	13	3	-	-	-	4	9
31	-	-	-	-	11	2	1	1	1	4	12
31-5	-	-	-	-	8	1	2	-	2	8	10
32	-	-	-	-	6	2	-	3	-	9	4
32-5	-	-	-	2	3	1	-	2	-	5	11
33	-	-	-	-	6	-	-	-	-	8	-
33-5	-	-	-	-	10	-	-	-	-	8	-
34	-	-	-	-	3	1	-	1	-	3	-

In many of these cases the division into groups is obvious. A few of them may be considered in detail, in order to make clear the rate of growth.

In the Firth of Forth, in May, from 9th to 13th, a number of gurnards were taken, belonging to at least five annual series (pl. XIII.). The smallest, representing the fishes from the previous year's spawning, and being therefore from seven months to fully a year old, and principally about eleven months, numbered 21. They varied in size from 7.9cm. to 13.1cm. ( $3\frac{1}{8}$ – $5\frac{1}{8}$  inches), a range or difference of 5.2cm.; the maximum number measured about 9cm. (the apex, mode or maximum ordinate, of the curve), the mean was about 10.5cm., and the arithmetical average 0.1cm., or 4 inches.

The next group numbered 32, varying in size from 14cm. to 19.1cm. ( $5\frac{1}{2}$ – $7\frac{1}{2}$  inches), and were a year older, on an average about 1 year and 11 months. The maximum number were at 16.5cm., the mean was 16cm., and the arithmetical average 16.21cm., or  $6\frac{3}{8}$  inches. The growth from the previous series was thus about 6.1cm., or  $2\frac{3}{8}$  inches, which represents the increment in a year.

The third series numbered 20, the range was from 19.6cm. to 24.1cm., ( $7\frac{3}{4}$ – $9\frac{1}{2}$  inches), the maximum number were at 21cm., the mean was 21.3cm., and the arithmetical average was 21.54cm., or  $8\frac{1}{2}$  inches. These fishes were very nearly three years old, and the growth indicated in a year from the preceding group was 5.3cm., or  $2\frac{1}{8}$  inches.

The fourth series numbered 14, varying in length from 25.2cm. to 28.9cm. ( $9\frac{1}{2}$ – $11\frac{3}{8}$  inches); the maximum number were at 27cm., the mean was 26.5cm., and the average 27cm., or  $10\frac{3}{8}$  inches. The indicated growth in a year amounted to 5.46cm., or  $2\frac{1}{8}$  inches. These gurnards were approximately four years old.

A fifth series consisted of 13 fish, varying from 29.7cm. to 32.5cm. ( $11\frac{3}{4}$ – $13\frac{3}{4}$  inches); the maximum number were at 30cm., the mean was 31cm., and the calculated arithmetical average was 30.97cm., or  $12\frac{1}{8}$  inches. The growth from the previous series was about  $1\frac{1}{2}$  inches, and the age of the series nearly five years.

Towards the end of July another collection from the Firth of Forth was examined (pl. XIII.). The first series of 32 varied from 11cm. to 13.7cm. ( $4\frac{3}{8}$ – $5\frac{3}{8}$  inches), and was obviously incomplete by the absence of many of the smaller gurnards, the range of sizes amounting to only 2.7cm. The maximum number were at 12.5cm., the mean was the same, and the average 12.4cm., or  $4\frac{1}{8}$  inches. These fish were probably rather over one year of age.

The second group was represented by 107 gurnards, ranging in length from 14.3cm. to 20.2cm. ( $5\frac{5}{8}$ – $7\frac{1}{8}$  inches); the maximum number were at 16.5cm., the mean was 17cm., and the average was 17.1cm., or  $6\frac{3}{4}$  inches. The indicated growth from the previous generation was 4.7cm., which is too small, owing to the reason stated—the absence of the smaller fishes.

The next group numbered 12, varying from 21cm. to 26.5cm.; the maximum number were at 22.5cm., the mean was 23.5cm., and the calculated average 23.3cm., or  $9\frac{3}{8}$  inches. These fish were about three years of age, and the growth indicated from the previous series was 6.2cm., or  $2\frac{7}{8}$  inches, which is too great.

In the August collection (pl. XIII.), the first series included 78 gurnards from 10.8cm. to 15.6cm. ( $4\frac{1}{4}$ – $5\frac{3}{8}$  inches); the maximum number or mode was about 13cm., which was also the mean, while the computed average was 13.14cm., or  $5\frac{1}{8}$  inches. These fish were about 13 or 14 months old.

The second series numbered 33 fishes, the sizes ranging from 16.4cm. to 22.6cm. ( $6\frac{1}{2}$ – $8\frac{3}{8}$  inches); the maximum numbers were at 20cm., the

mean was 19cm., and the average 19.26cm., or  $7\frac{5}{8}$  inches. The growth indicated in a year, from the former series, was 6.12cm., or  $2\frac{1}{8}$  inches. These fishes were over two years of age.

In this collection there were also a few of larger size, but their number is not sufficient to indicate grouping.

From Aberdeen Bay a number of collections were also obtained, some of which may be referred to (pl. XIII.).

On the 5th July, the first series was represented by 109 gurnards, measuring from 9.7cm. to 13.8cm. ( $3\frac{1}{8}$ – $5\frac{1}{2}$  inches); the greater number measured about 11.5cm. to 12cm., the mean was 12cm., and the computed average 11.56cm., or  $4\frac{1}{8}$  inches. These fish were about a year old.

The next series included 61 gurnards from 14.2cm. to 19.9cm. ( $5\frac{5}{8}$ – $7\frac{7}{8}$  inches). The maximum number were at 17cm., the mean size was also 17cm., and the computed average 16.90cm., or  $6\frac{5}{8}$  inches. The amount of growth indicated in a year from the preceding series was thus about 5.34cm., or  $2\frac{1}{8}$  inches.

On the 30th and 31st July, the first series comprised 12 gurnards from 11.2cm. to 15.1cm. ( $4\frac{3}{8}$ –6 inches). The maximum number were at 14cm., the mean was 13cm., and the average 13.49cm., or  $5\frac{1}{8}$  inches, which is about 1cm. greater than it ought to be, owing to the absence of small fishes.

The next series consisted of 33 gurnards, measuring from 16.7cm. to 21.4cm. ( $6\frac{9}{16}$ – $8\frac{7}{16}$  inches). The maximum number were at 18.5cm., the mean was the same, and the average was 18.73cm., or  $7\frac{3}{8}$  inches. These fish were over two years old, and the amount of growth indicated in a year from the preceding series was 5.24cm., or 2 inches, which is rather under the normal, owing to the absence of small fishes in the preceding series.

On 1st September the young gurnards are represented in the collection. On that day 17 were taken, measuring from 32mm. to 71mm. ( $1\frac{1}{4}$ – $2\frac{3}{4}$  inches); the maximum number were at 5cm., which was also the mean, and the computed average was 54.1cm., or  $2\frac{1}{8}$  inches. The age of these fishes was probably 3 or 4 months.

On the 20th September five of this series were got, measuring from 5.3cm. to 9.7cm., but the October collection shows that the smaller fishes were not present.

The second group numbered 52, varying in length from 11.6cm. to 16.7cm. ( $4\frac{9}{16}$ – $6\frac{9}{16}$  inches); the maximum was 15cm., the mean 14cm., and the average 14.57cm., or  $5\frac{3}{4}$  inches, the probable age being about 16 months.

In the third series there were 37 gurnards, ranging from 17.2cm. to 22cm. ( $6\frac{3}{4}$ – $8\frac{3}{4}$  inches); the maximum number were at 20.5cm., the mean was 19.5cm., and the average 20.02cm., or  $7\frac{7}{8}$  inches. The growth of this series, about 2 years and 4 months of age, was apparently 5.45cm., or  $2\frac{1}{8}$  inches in the year.

A collection on the 13th October contained 24 gurnards of the first series. They varied in length from 2.1cm. to 8cm. ( $\frac{7}{8}$ – $3\frac{1}{8}$  inches); the maximum number were at 6cm., and the mean was 6cm., the computed average being 4.65cm., or  $1\frac{1}{2}$  inches, which is too small, owing to the smaller fishes being over-represented.

The next series included 18 gurnards, from 12cm. to 16.8cm. ( $4\frac{3}{4}$ – $6\frac{5}{8}$  inches); the maximum number were at 14.5cm., the mean was the same, and the average 14.63cm., or  $5\frac{3}{4}$  inches. These fish were about 1 year and 4 months old.

The third series comprised only two fishes, 19.3cm. and 22.8cm. in length.

On 8th October another collection contained four of the first group. They varied from 5·7cm. to 8·5cm. The second group consisted of 15 fishes, from 10·9cm. to 17·4cm. ( $4\frac{5}{8}$ – $6\frac{7}{8}$  inches); the mean was 14·5cm., and the average 14·49cm., or  $5\frac{3}{4}$  inches.

A third series was represented by five fishes, from 21·3cm. to 22·7cm., the average being 21·72cm., or  $8\frac{9}{16}$  inches. The smaller fishes of the series were not present.

Another collection, from the Dornoch Firth on 5th and 11th November, may be referred to. The first group contained 82 gurnards, from 5·9cm. to 11·3cm. ( $2\frac{1}{8}$ – $4\frac{7}{8}$  inches); the maximum number were at 8cm., the mean was about 8·3cm., and the average 8·44cm., or  $3\frac{5}{16}$  inches.

There were eleven gurnards in the next group, the sizes ranging from 12·1cm. to 18·5cm., ( $4\frac{3}{4}$ – $7\frac{5}{8}$  inches); the mean was 15cm., and the average 14·98cm., or  $5\frac{1}{2}$  inches. The apparent growth in the year from the preceding generation was thus 6·54cm., or  $2\frac{9}{16}$  inches.

The third series contained ten fishes, from 19·2cm. to 21·5cm. ( $7\frac{9}{16}$ – $8\frac{5}{16}$  inches). The maximum number were at 21cm., and the average was at 20·62cm., or  $8\frac{1}{8}$  inches. These fishes were in the middle of their third year; the apparent growth from the previous series was 5·64cm., or  $2\frac{3}{8}$  inches.

The other groups were represented by a few fishes. An examination of the figures in the Tables appended will show that the growth in the Firth of Forth in 100 days, from the early part of May to the middle of August, amounted for the first group, that is, fish about a year or more of age, to 3cm., or  $1\frac{3}{8}$  inches. Precisely the same amount is indicated for the growth of the corresponding series in 100 days, from the beginning of July to the middle of October, in Aberdeen Bay. The older group, fish about two years or over, increased also by 3cm., in the 100 days in the Forth, and by 1·83cm. in 25 days and 1·29cm. in 76 days in Aberdeen Bay.

Date and Place.	Number of Days.	SERIES I.		SERIES II.	
		Average Size.	Increase.	Average Size.	Increase.
<b>ABERDEEN BAY.</b>		Cm.	Cm.	Cm.	Cm.
<i>Summer.</i>					
5th July, . . . . .	—	11·56	—	16·90	—
30th–31st July, . . . .	25	(13·49)	1·93	18·73	1·83
20th September, . . . .	76	14·57	3·01	20·02	1·29
13th October, . . . . .	100	14·63	3·07	—	—
<i>Winter.</i>					
5th July, . . . . .	265	16·90	2·27	—	—
<b>FIRTH OF FORTH.</b>					
<i>Summer.</i>					
9th–13th May, . . . . .	—	10·1	—	16·2	—
23rd July, . . . . .	73	12·40	2·29	17·1	0·9
16th–21st August, . . . .	100	13·14	3·03	19·26	3·06
<i>Winter.</i>					
9th–13th May, . . . . .	265	16·21	3·07	21·54	2·28

About half the growth thus takes place during the few months in summer, the growth in the 100 days being almost exactly the same as in the remaining 265 days, which include the winter months.

If the differences between the averages of the successive series are considered, as in the following Table, it will be found that between the first and second groups the differences vary from 5·24cm. to 9·98cm., and the mean of this is 6·40cm., or 2½ inches. It appears, however, to be a trifle too high. The best collections, in which the series are most equally represented at the different sizes, indicate a very slightly smaller rate of growth. It may be said that the gurnard in the early generations grows about 6·0cm., or 2½-2½ inches, in a year.

In the later generations growth is slower. In some of the collections five or six series belonging to different years can be made out.

In some large collections made during the spawning period, in Sinclair Bay, Moray Firth, the sexes were determined and separately measured, but the tables of measurements and the curves constructed on them did not show the grouping very clearly. The clue furnished by the study of the smaller collections above described enables the divisions between the earlier series to be indicated, and it will be seen they agree with the statements made as to the grouping and the rate of growth. These collections from the northern part of the Moray Firth show that at least eight or nine generations are present.

# GURNARD.

Date and Place.	Group	No.	Range of Size. Cm	Difference. Cm.	Modal Size.	Mean Cm.	Arithmetic Average.		Approximate Age.		Apparent Growth from Preceding Series.	
							Cm.	Inch.	Years	M'ths	Cm.	Inch.
FIRTH OF FORTH— May 9-13, 1901, - -	I.	21	7·9-13·1	5·2	9	10·5	10·11	4	..	11	..	..
	II.	32	14·0-19·1	5·1	16·5	16	16·21	6½	1	11	6·1	2½
	III.	50	19·6-24·1	4·5	21	21·3	21·54	8½	2	11	5·3	2½
	IV.	14	25·2-28·9	3·7	27	26·5	27·0	10½	3	11	5·46	2½
	V.	13	29·7-32·5	2·8	30	31	30·97	12½	4	11	3·97	..
	VI.	3	34·3	..	..	..	..	..	..	..	..	..
July 23, 1901, - -	I.	32	11·0-13·7	2·7	12·5	12·5	[12·4	4½]	1	1	..	..
	II.	107	14·3-20·2	5·9	16·5	17	17·1	6½	2	1	[4·7	1½]
	III.	12	21·0-26·5	5·5	22·5	23·5	23·3	9½	3	1	6·2	2½
August 16-21, 1901, -	I.	78	10·8-15·6	4·8	13	13	13·14	5½	1	1-2	..	..
	II.	33	16·4-22·6	6·2	20	19	19·26	7½	2	1-2	6·12	2½
ABERDEEN BAY— July 5, 1901, - -	I.	109	9·7-13·8	4·1	11·5-12	12	11·56	4½	1	..	..	..
	II.	61	14·2-19·9	5·7	17	17	16·90	6½	2	..	5·34	2½

[illegible]

I.—PLAICE, LOCHFYNE, 1901.

PUSH-NET.

(1) JULY.				(2) AUGUST.			
Col. I. Big Harbour,	-	-	1st and 3rd	Col. I. Big Harbour,	-	-	28th, 29th
„ II. Salen,	-	-	2nd	„ II. Salen,	-	-	29th
„ III. Strachur,	-	-	4th and 5th	„ III. Strachur,	-	-	30th
„ IV. Inveraray,	-	-	4th and 5th	„ IV. Inveraray,	-	-	30th, 31st
„ V. Lochgilphead,	-	-	2nd				
„ VI. Cairndow,	-	-	6th				

JULY.								AUGUST.				
MM.	I.	II.	III.	IV.	V.	VI.	Total.	I.	II.	III.	IV.	Total.
11	-	-	-	-	-	-	-	-	-	-	-	-
12	5	-	-	-	-	-	5	-	-	-	-	-
13	5	-	-	-	-	-	5	-	-	-	-	-
14	6	1	-	-	-	-	7	-	-	-	-	-
15	9	-	-	-	-	-	9	-	-	-	-	-
16	8	1	1	-	-	-	10	-	-	-	-	-
17	3	3	-	-	-	-	6	-	-	-	-	-
18	11	3	4	-	-	-	18	-	-	-	-	-
19	11	8	8	1	-	-	28	-	-	-	-	-
20	16	22	10	-	-	-	48	-	-	-	-	-
21	23	25	10	-	-	-	58	-	-	-	-	-
22	31	51	25	-	-	-	107	-	-	-	-	-
23	39	70	36	5	-	-	150	-	-	-	-	-
24	54	80	54	4	1	-	193	-	-	-	-	-
25	76	114	52	8	1	-	251	-	-	-	-	-
26	75	97	42	3	1	-	218	-	-	-	-	-
27	86	89	69	14	-	-	258	-	-	-	-	-
28	67	70	64	18	2	1	222	-	-	-	-	-
29	67	62	59	42	3	1	234	-	-	-	-	-
30	56	44	46	68	1	2	217	-	-	-	-	-
31	49	18	44	78	-	-	189	-	-	-	-	-
32	39	10	27	91	5	1	173	-	-	-	-	-
33	15	8	25	82	5	-	135	-	-	-	-	-
34	16	5	14	92	2	-	129	1	-	2	-	3
35	10	4	11	94	2	-	121	-	-	2	-	2
36	7	6	17	86	2	2	120	-	-	1	-	1
37	8	5	12	81	2	2	110	1	-	3	-	4
38	7	1	10	71	3	-	92	-	-	3	-	3
39	6	1	7	55	1	-	70	2	-	7	-	9
40	4	2	6	49	5	-	66	3	-	4	-	7
41	2	2	2	31	2	1	40	7	1	5	-	13
42	1	-	3	31	3	-	38	10	3	5	-	18
43	2	1	1	26	2	-	32	4	-	5	-	9
44	1	-	2	22	-	-	25	10	1	4	-	15
45	1	-	1	22	4	1	29	10	2	1	-	13
46	-	-	1	18	5	-	24	6	3	2	-	11
47	2	-	2	15	-	-	19	17	3	2	-	22
48	1	-	1	9	2	-	13	15	3	2	1	21
49	1	2	-	8	-	1	12	16	8	1	-	25
50	1	-	1	10	1	-	13	15	4	2	-	21
51	1	1	1	8	1	-	12	14	7	1	1	23
52	-	-	-	7	1	1	9	21	1	-	-	22
53	-	-	-	3	-	-	3	13	3	1	-	17
54	-	-	-	2	-	-	2	16	3	-	-	19
55	-	-	-	3	-	-	3	17	2	1	2	22
56	-	-	-	2	-	-	2	14	3	-	1	18
57	-	-	-	3	-	-	3	12	2	-	4	18
58	-	-	-	1	-	-	1	9	-	-	1	10
59	-	-	-	-	-	-	-	8	1	2	4	15
60	-	-	-	-	-	-	-	10	1	1	8	20
61	-	-	-	-	-	-	-	8	-	1	5	14
62	-	-	-	-	-	-	-	3	-	-	11	14
63	-	-	-	-	-	-	-	5	-	1	12	16
64	-	-	-	-	-	-	-	6	-	-	6	11
65	-	-	-	-	-	-	-	2	-	-	9	11
66	-	-	-	-	-	-	-	2	-	-	6	8
67	-	-	-	-	-	-	-	1	-	1	9	11
68	-	-	-	-	-	-	-	-	-	2	5	7
69	-	-	-	-	-	-	-	4	-	1	5	10
70	-	-	-	-	-	-	-	1	-	-	8	9
71	-	-	-	-	-	-	-	2	-	-	3	5
72	-	-	-	-	-	-	-	2	1	-	7	10
73	-	-	-	-	-	-	-	-	-	2	3	5
74	-	-	-	-	-	-	-	1	-	1	2	4

## I.—PLAICE, LOCHFYNE, 1901—continued.

JULY.								AUGUST.				
MM.	I.	II.	III.	IV.	V.	VI.	Total.	I.	II.	III.	IV.	Total.
75	-	-	-	-	-	-	-	2	-	3	5	10
76	-	-	-	-	-	-	-	-	-	1	1	2
77	-	-	-	-	-	-	-	1	-	1	3	5
78	-	-	-	-	-	-	-	1	-	-	1	2
79	-	-	-	-	-	-	-	1	-	1	4	6
80	-	-	-	-	-	-	-	-	-	-	2	2
81	-	-	-	-	-	-	-	-	-	1	-	1
82	-	-	-	-	-	-	-	-	-	1	2	3
83	-	-	-	-	-	-	-	1	-	1	-	2
84	-	-	-	-	-	-	-	-	-	1	-	1
85	-	-	-	-	-	-	-	-	-	-	1	1
86	-	-	-	-	-	-	-	1	-	1	-	2
87	-	-	-	-	-	-	-	-	-	1	1	2
88	-	-	-	-	-	-	-	-	-	1	-	1
	822	806	668	1163	57	13	3529	292	52	79	133	556

## II.—PLAICE, LOCHFYNE, 1903.

## PUSH-NET.

MM.	INVERARAY.		STRACHUR.		BIG HARBOUR.		LOCH- GILF- HEAD.	Total, June	Total, July
	June 22	July 10-11	June 24	July 13	June 25	July 13	June 26		
14	-	-	-	-	-	-	-	-	-
15	-	-	5	-	-	-	-	5	-
16	-	-	9	-	-	-	-	9	-
17	1	1	12	-	1	-	1	15	1
18	1	2	11	-	1	-	-	13	2
19	1	2	12	1	3	3	1	17	6
20	4	2	11	4	2	4	1	18	10
21	5	-	6	3	2	5	2	15	8
22	5	3	6	5	3	6	-	14	14
23	8	4	5	6	4	6	-	17	16
24	5	8	6	4	6	12	-	17	24
25	5	7	3	4	1	19	-	9	30
26	2	8	4	3	1	27	-	7	38
27	3	7	3	5	-	27	-	6	39
28	8	4	-	5	1	30	1	10	39
29	6	5	1	2	-	26	1	8	33
30	8	6	-	1	-	29	-	8	36
31	4	9	-	-	-	24	1	5	33
32	7	8	-	-	-	17	-	7	25
33	3	8	-	1	-	17	-	3	26
34	2	6	-	-	-	7	1	3	13
35	2	3	-	-	-	7	-	2	10
36	1	3	-	1	-	6	1	2	10
37	-	1	-	1	-	4	-	-	6
38	-	1	-	-	-	5	-	-	6
39	1	1	-	1	-	2	-	1	4
40	-	2	-	-	-	-	-	-	2
41	-	-	-	-	-	2	-	-	2
42	1	-	-	-	-	1	1	2	1
43	-	-	-	-	-	1	1	1	1
44	2	1	-	-	-	2	-	2	3
45	-	-	-	-	-	-	-	-	-
46	-	-	-	1	-	1	1	1	2
47	1	1	-	1	-	-	-	1	2
48	-	1	-	-	-	2	-	-	3
49	-	-	-	-	-	-	-	-	-
50	-	1	-	-	-	-	-	-	1
51	-	-	-	-	-	1	-	-	1
52	-	-	-	-	-	-	-	-	-
53	-	-	-	-	-	-	-	-	-
54	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	-
56	-	-	-	-	-	-	-	-	-
57	-	-	-	1	-	-	-	-	1
	86	106	94	50	25	293	13	218	448



### III.—PLAICE, LOCHFYNE, 1901.

#### PUSH-NET.

(Preceding Table arranged in .5 Centimetres.)

(1) JULY.  
Col. I. Big Harbour.  
" II. Salen.  
" III. Strachur.  
" IV. Inveraray.  
" V. Lochgilphead.  
" VI. Cairndow.

(2) AUGUST.  
Col. I. Big Harbour.  
" II. Salen.  
" III. Strachur.  
" IV. Inveraray.

JULY 1-6.								AUGUST 28-31.				
CM.	I.	II.	III.	IV.	V.	VI.	Total.	I.	II.	III.	IV.	Total.
1	5	-	-	-	-	-	5	-	-	-	-	-
.5	31	5	1	-	-	-	37	-	-	-	-	-
2	92	109	57	1	-	-	259	-	-	-	-	-
.5	330	450	253	34	3	-	1070	-	-	-	-	-
3	278	204	240	297	11	5	1035	-	-	-	-	-
.5	58	28	79	435	13	4	615	2	-	8	-	10
4	20	6	28	237	14	1	306	22	4	24	-	50
.5	6	1	7	103	11	1	129	47	9	14	-	70
5	4	3	3	42	5	2	59	81	23	6	2	112
.5	-	-	-	13	-	-	13	72	13	2	7	94
6	-	-	-	1	-	-	1	38	2	4	29	73
.5	-	-	-	-	-	-	-	13	-	2	42	57
7	-	-	-	-	-	-	-	9	1	3	28	41
.5	-	-	-	-	-	-	-	4	-	8	14	26
8	-	-	-	-	-	-	-	2	-	3	9	14
.5	-	-	-	-	-	-	-	2	-	4	2	8
9	-	-	-	-	-	-	-	-	-	1	-	1
	822	806	668	1163	57	13	3529	292	52	79	133	556

1903.

JUNE 22-26.						JULY 10-13.			
CM.	I.	II.	III.	IV.	Total.	I.	II.	III.	Total.
1	-	-	-	-	-	-	-	-	-
.5	1	26	1	1	29	1	-	-	1
2	16	46	11	4	77	9	13	18	40
.5	23	21	12	-	56	34	22	91	147
3	33	1	1	3	38	32	8	126	166
.5	8	-	-	2	10	21	3	41	65
4	2	-	-	1	3	4	1	10	15
.5	3	-	-	2	5	2	2	4	8
5	-	-	-	-	-	2	-	3	5
.5	-	-	-	-	-	-	1	-	1
	86	94	25	13	218	105	50	293	448

#### IV.—PLAICE.

[illegible]



## V.—PLAICE.

Cm.	BURGHEAD BAY, 6th December 1904.											
	Haul 1.			Haul 5.			Haul 6.			Hauls 1, 5, 6.		
	Fem.	Male.	Total.	Fem.	Male.	Total.	Fem.	Male.	Total.	Fem.	Male.	Total.
18	1	-	1	-	-	-	-	-	-	1	-	1
19	-	-	-	-	-	-	-	-	-	-	-	-
20	1	1	2	-	-	-	-	-	-	1	1	2
21	-	4	4	-	-	-	-	-	-	-	4	4
22	2	1	3	-	1	1	-	-	-	2	2	4
23	1	5	6	2	2	4	-	-	-	3	7	10
24	3	1	4	1	1	2	-	1	1	4	3	7
25	4	4	8	1	-	1	-	1	1	5	5	10
26	6	9	15	9	17	26	3	2	5	18	28	46
27	14	19	33	16	24	40	1	5	6	31	48	79
28	27	38	65	25	32	57	2	3	5	54	73	127
29	27	24	51	29	41	70	5	10	15	61	75	136
30	30	25	55	30	43	73	8	10	18	68	78	146
31	34	31	65	30	34	64	9	11	20	73	76	149
32	22	26	48	24	37	61	4	11	15	50	74	124
33	25	25	50	19	31	50	4	5	9	48	81	109
34	14	20	34	24	32	56	2	6	8	40	58	98
35	19	30	49	24	30	54	3	9	12	46	69	115
36	21	24	45	23	22	45	4	8	12	48	54	102
37	24	25	49	21	29	50	3	5	8	48	59	107
38	21	25	46	18	22	40	8	5	13	47	52	99
39	13	11	24	15	22	37	2	3	5	30	36	66
40	16	12	28	17	6	23	7	1	8	40	19	59
41	8	10	18	10	8	18	2	3	5	20	21	41
42	5	4	9	5	3	8	1	-	1	11	7	18
43	2	-	2	6	4	10	-	2	2	8	6	14
44	4	1	5	3	3	6	2	1	3	9	5	14
45	2	-	2	1	1	2	1	1	2	4	2	6
46	4	-	4	1	-	1	-	-	-	5	-	5
47	4	-	4	4	-	4	-	-	-	8	-	8
48	2	-	2	2	1	3	-	-	-	4	1	5
49	1	-	1	4	-	4	-	-	-	5	-	5
50	-	-	-	1	-	1	2	-	2	3	-	3
51	1	-	1	-	1	1	-	-	-	1	1	2
52	1	-	1	-	-	-	-	-	-	1	-	1
53	2	-	2	1	-	1	-	-	-	3	-	3
54	3	-	3	-	-	-	-	-	-	3	-	3
55	-	-	-	-	-	-	-	-	-	-	-	-
56	1	-	1	1	-	1	-	-	-	2	-	2
57	-	-	-	-	-	-	-	-	-	-	-	-
58	-	-	-	-	-	-	-	-	-	-	-	-
59	-	-	-	1	-	1	-	-	-	1	-	1
60	-	-	-	-	-	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-	-	-	-	-	-
62	1	-	1	1	-	1	-	-	-	2	-	2
63	1	-	1	-	-	-	-	-	-	1	-	1
64	1	-	1	-	-	-	-	-	-	1	-	1
65	-	-	-	-	-	-	-	-	-	-	-	-
66	-	-	-	-	-	-	-	-	-	-	-	-
67	-	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	-	-	-	-	-	-	-	-	-
69	-	-	-	-	-	-	-	-	-	-	-	-
70	1	-	1	-	-	-	-	-	-	1	-	1
71	-	-	-	-	-	-	-	-	-	-	-	-
72	-	-	-	-	-	-	-	-	-	-	-	-
73	-	-	-	-	-	-	-	-	-	-	-	-
74	1	-	1	-	-	-	-	-	-	1	-	1
	370	375	745	360	447	816	73	103	176	612	925	1737

VI.—PLAICE.

Cm.	BURG- HEAD BAY.	DORNOCH FIRTH.									
		20th Oct. 1903.	22nd Oct. 1903.	11th Nov. 1903.	13th Nov. 1903.	Total, 11th & 13th	27th Dec. 1903.	7th December 1904.			
								Fem.	Male.	?	Total.
5	-	-	-	-	-	-	-	-	-	-	
6	-	-	-	-	-	-	-	-	1	1	
7	-	-	-	-	-	-	-	-	5	5	
8	-	-	-	-	-	-	-	1	7	8	
9	-	-	-	-	-	-	-	-	5	5	
10	-	-	-	-	-	-	-	-	-	-	
11	-	-	-	-	-	-	-	-	-	-	
12	-	-	-	-	-	-	-	-	3	3	
13	-	-	-	-	-	-	-	-	6	6	
14	-	-	1	1	2	1	-	1	3	4	
15	-	5	-	1	1	3	-	-	-	-	
16	-	2	-	1	1	1	-	-	-	-	
17	1	6	-	-	-	1	1	-	-	1	
18	-	5	-	-	-	-	-	1	-	1	
19	1	2	-	-	-	-	1	-	-	1	
20	-	3	-	1	1	-	2	-	-	2	
21	3	15	1	4	5	-	1	1	-	2	
22	5	28	3	4	7	3	2	11	-	13	
23	14	34	3	8	11	-	2	4	-	6	
24	22	31	2	8	10	2	4	6	-	10	
25	25	38	6	12	18	1	3	5	-	8	
26	35	35	2	10	12	1	5	7	-	12	
27	19	28	15	20	35	1	6	-	-	6	
28	15	18	10	22	32	4	2	5	-	7	
29	10	25	10	20	30	8	4	3	-	7	
30	9	8	13	23	36	8	6	10	-	16	
31	16	10	8	22	30	11	6	10	-	16	
32	12	15	5	19	24	11	5	5	-	10	
33	7	14	1	7	8	9	1	6	-	7	
34	7	6	7	14	21	9	5	4	-	9	
35	8	8	2	6	8	8	3	3	-	6	
36	6	6	2	8	10	10	1	-	-	1	
37	4	6	2	8	10	8	-	5	-	5	
38	3	2	3	3	6	9	-	-	-	-	
39	3	1	-	-	-	2	-	1	-	1	
40	2	6	1	2	3	2	1	-	-	1	
41	-	2	2	-	2	1	1	-	-	1	
42	1	1	-	-	-	1	-	-	-	-	
43	1	-	-	1	1	2	-	-	-	-	
44	-	1	-	-	-	-	-	-	-	-	
45	-	-	-	-	-	1	-	-	-	-	
46	-	-	-	1	1	-	-	-	-	-	
47	-	-	-	-	-	-	1	-	-	1	
48	-	-	-	-	-	-	-	-	-	-	
49	-	-	-	1	1	1	-	-	-	-	
50	-	-	-	-	-	-	-	-	-	-	
51	1	1	-	-	-	-	-	-	-	-	
52	-	-	-	-	-	-	-	-	-	-	
53	1	1	-	-	-	-	-	-	-	-	
54	1	-	-	-	-	-	-	-	-	-	
55	-	-	-	-	-	-	-	-	-	-	
56	1	-	-	-	-	-	-	-	-	-	
	233	363	99	227	326	121	63	89	30	182	



[illegible]

## VIII.—COMMON DAB, ABERDEEN BAY.

- Col. I. Off Ythan, 13th Nov. 1900. Shrimp net, 6-9 fathoms.  
 „ II. Off Ythan, 19th Nov. 1900. Shrimp net, 2-10 fathoms.  
 „ III. Donmouth to Bathing Station, 8th April 1904. Shrimp net, 4-6 fathoms.  
 „ IV. Donmouth to Bathing Station, 16th April 1904. Shrimp net, 4-6 fathoms.  
 „ V. Donmouth to Bathing Station, 26th April 1904. Shrimp net, 4-6 fathoms.  
 „ VI. Totals of III.-V.  
 „ VII. Donmouth to Bathing Station, 4th May 1904. Shrimp net, 3-7 fathoms.  
 „ VIII. Donmouth to Bathing Station, 12th, 18th May 1904. Shrimp net, 3-7 fathoms.  
 „ IX. Donmouth to Bathing Station, 1st Sept. 1904. Shrimp net, 4-9 fathoms.  
 „ X. Off Quarries, 11th Feb. 1905. Small-meshed net, 8-12 fathoms.  
 „ XI. Donmouth to Black Dog, 27th March 1905. Small-meshed net, 5-10 fathoms.  
 „ XII. Donmouth to Black Dog, 30th Jan. 1906. Small-meshed trawl, 8 fathoms.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
2	3	-	-	-	-	-	-	-	1	-	-	-
5	3	-	18	5	3	26	-	-	10	-	-	1
8	4	-	60	17	13	90	3	2	43	1	4	31
5	5	6	104	55	54	213	10	8	75	4	7	99
4	14	13	61	76	54	191	11	16	77	5	11	105
5	9	22	22	66	36	124	9	25	51	4	24	46
5	16	26	12	54	13	79	4	14	15	1	28	31
5	19	23	4	17	1	22	-	4	6	-	23	8
6	13	11	-	10	-	10	-	1	1	-	26	1
5	19	6	1	4	-	5	-	-	-	1	19	1
7	3	1	-	1	1	2	-	-	-	-	5	-
5	4	-	-	1	2	3	-	-	-	-	2	-
8	2	-	-	2	-	2	-	-	-	-	-	-
5	-	-	-	-	1	1	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	1	-	-	-
5	-	-	-	-	-	-	-	-	2	-	-	-
10	-	1	-	-	-	-	-	-	2	-	-	-
5	-	-	-	-	-	-	-	-	8	1	-	-
11	-	-	-	-	1	1	-	-	9	-	-	-
5	-	-	-	-	2	2	-	-	7	-	-	-
12	-	-	-	-	3	3	-	-	7	-	-	-
5	-	1	-	-	8	8	-	-	3	-	-	-
13	-	-	1	-	10	11	-	-	5	-	-	-
5	-	-	-	-	6	6	-	-	4	-	-	-
14	-	-	-	-	5	5	-	-	5	-	-	-
5	-	-	-	-	6	6	-	-	2	-	-	-
15	-	-	-	1	3	4	-	-	4	-	-	-
5	-	-	-	-	2	2	-	-	1	-	-	-
16	-	1	-	-	3	3	-	-	-	-	-	-
5	-	-	-	-	1	1	-	-	2	1	-	-
17	-	-	-	-	-	-	-	-	1	-	-	-
5	-	-	-	-	-	-	-	-	1	-	-	-
18	-	-	-	-	1	1	-	-	3	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-
	114	111	283	309	229	821	37	70	366	18	154	323



IX.—COMMON DABS.

DORNOCH FIRTH—MORAY FIRTH.

Col. I. 9th February 1905—6½–10 fathoms.  
 „ II. 31st March 1904.  
 „ III. 8th June 1903—10–11 fathoms.  
 „ IV. 22nd October 1903—8–13 fathoms.

Col. V. 7th December 1904.  
 „ VI. 27th December 1903.  
 „ VII. 23th December 1903.

Cm.	I.	II.	III.	IV.	V.	VI.			VII.		
						Female.	Male.	Total.	Female.	Male.	Total.
2	-	-	-	-	-	-	-	-	-	-	-
2½	-	-	-	-	4	-	-	-	-	-	1
3	14	-	-	-	30	-	-	-	-	-	3
3½	34	-	-	-	88	-	-	-	-	-	-
4	66	-	-	-	60	-	-	-	-	-	2
4½	83	-	-	-	19	-	-	-	-	-	1
5	72	1	-	-	8	-	-	-	-	-	-
5½	48	1	-	-	7	-	-	-	-	-	-
6	33	1	-	-	3	-	-	-	1	1	2
6½	17	-	-	-	2	-	-	-	2	3	5
7	8	-	1	1	-	-	-	-	3	2	5
7½	2	-	1	-	-	-	-	-	2	-	2
8	2	-	2	-	-	-	-	-	1	1	2
8½	2	1	-	3	-	-	-	-	3	1	4
9	4	-	-	6	1	-	1	1	4	7	11
9½	6	-	2	75	-	7	3	10	15	39	54
10	17	-	-	98	2	9	9	18	43	59	102
10½	23	2	1	182	6	17	11	28	71	50	121
11	22	2	1	85	9	12	14	26	49	38	87
11½	15	2	-	69	6	16	6	22	31	25	56
12	4	1	-	41	3	7	3	10	17	16	33
12½	3	-	-	24	2	6	4	10	11	9	20
13	8	2	1	8	2	5	3	8	6	9	15
13½	10	1	2	14	1	3	5	8	6	9	15
14	5	3	-	9	3	3	5	8	5	11	16
14½	5	5	1	14	2	7	6	13	7	8	15
15	7	-	1	11	1	1	4	5	3	5	8
15½	7	3	1	14	1	5	3	8	10	9	19
16	4	3	1	3	-	5	1	6	5	3	8
16½	1	3	-	9	-	4	-	4	2	2	4
17	1	3	-	6	-	3	-	3	6	4	10
17½	1	5	1	5	-	1	-	1	2	1	3
18	-	3	-	3	-	1	-	1	1	1	2
18½	-	4	-	12	-	1	-	1	1	1	2
19	-	2	-	3	-	-	-	-	2	-	2
19½	-	1	-	3	-	-	-	-	1	-	1
20	-	3	-	5	-	1	-	1	-	1	1
21	-	-	-	4	-	-	-	-	1	-	1
22	-	-	-	3	-	-	-	-	-	-	-
23	-	1	-	1	-	-	-	-	1	-	1
24	-	-	-	3	-	-	-	-	-	-	-
25	-	-	-	4	-	-	-	2	-	-	-
26	-	-	-	2	-	-	-	1	-	-	-
27	-	-	-	1	-	-	-	1	-	-	-
28	-	-	-	1	-	-	-	3	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	1	-	-	-	1	-	-	-
31	-	-	-	1	-	-	-	1	-	-	-
	524	53	16	724	258	114	78	201	312	315	624

**X.—COMMON DAB.**

WITCH GROUND, MORAY FIRTH.

Col. I. 14th November 1903.

„ II. 28th December 1903.

„ III. 23rd January 1904.

**SMITH BANK.**

Col. I. 1st April 1904.

COL. I. 1st April 1904.  
" II. 23rd October 1903.

„ III. 12th December 1904.

IV. 27th December 1903.

**BURGHAD BAY.**

Col. I. 20th October 1903.

„ II. 6th December 1904.

**OFF FINDHORN.**

Col. 1. 1st April 1904.

Cm.	WITCH GROUND (off Cromarty).					SMITH BANK.						BURGHAD BAY.		OFF FIND-HORN
	I.	II.	III.			I.	II.	III.	IV.			I.	II.	I.
			Fem.	Male.	Total.				Fem.	Male.	Total.			
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	1	-	-	-	10	-	-	-
3	-	-	-	-	-	-	-	-	-	-	27	-	-	-
5	-	-	-	-	-	-	-	-	-	-	8	-	-	-
4	-	-	-	-	-	-	-	-	-	-	5	-	-	-
5	-	-	-	-	-	-	-	-	-	-	3	-	-	-
5	-	-	-	-	-	-	-	-	-	-	2	-	-	-
5	-	-	-	-	-	-	-	-	-	-	5	-	-	-
6	-	-	-	-	-	-	-	-	-	-	3	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	3	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	1	2	1	-	1	-	-	-
9	-	1	-	-	-	-	2	2	3	2	5	1	-	-
5	1	9	-	-	-	-	13	8	13	10	23	4	-	-
10	1	8	-	1	1	2	25	28	22	19	41	12	-	-
5	4	18	3	2	5	1	47	85	31	42	73	11	-	-
11	5	4	3	8	11	5	66	111	48	55	103	8	-	-
5	7	7	4	7	11	10	82	124	75	44	119	14	-	1
12	12	1	5	12	17	8	54	99	59	37	96	10	-	2
5	12	9	10	19	29	11	81	91	56	36	92	26	-	-
13	7	3	11	34	45	3	68	87	35	34	69	16	-	-
5	15	1	21	90	111	5	77	123	41	26	67	24	-	2
14	6	1	23	116	139	7	75	109	36	20	56	20	-	1
5	9	6	41	134	175	8	89	118	42	22	64	18	6	5
15	5	2	44	115	159	10	63	114	34	14	48	15	4	2
5	8	6	43	115	158	9	66	92	32	9	41	27	-	2
16	7	5	24	85	109	4	30	83	26	6	34	16	1	2
5	4	6	37	78	115	4	36	56	25	4	29	21	3	1
17	5	5	24	62	86	2	29	34	18	2	20	14	6	4
5	5	7	23	61	84	3	22	45	14	-	14	15	8	7
18	1	5	19	83	52	-	16	25	7	-	7	7	4	1
5	2	8	24	18	42	3	9	22	6	1	7	16	6	6
19	5	2	20	21	41	1	5	14	8	-	3	4	6	4
5	2	5	8	14	22	1	6	14	5	1	6	4	7	4
20	4	5	20	11	31	-	-	13	3	2	5	16	14	6
21	2	6	11	7	18	1	-	15	2	1	3	15	14	2
22	1	5	11	2	13	1	-	7	2	1	3	2	10	4
23	-	3	4	1	5	-	-	2	2	-	2	1	9	-
24	-	3	7	2	9	-	-	3	1	-	1	-	6	-
25	-	2	1	-	1	-	-	1	1	-	1	1	14	-
26	-	2	3	-	3	-	-	1	-	1	1	-	7	-
27	-	2	1	1	2	-	-	1	-	-	-	-	9	-
28	-	-	-	-	-	-	-	1	-	-	-	-	8	-
29	-	1	1	-	1	-	-	2	-	-	-	-	14	-
30	-	-	-	-	-	-	-	-	-	-	-	-	13	-
31	-	-	1	-	1	-	-	-	-	-	-	-	8	-
32	-	-	1	-	1	-	-	-	-	-	-	-	15	-
33	-	-	-	-	-	-	-	-	-	-	-	-	5	-
34	-	-	-	-	-	-	-	-	-	-	-	-	3	-
35	-	-	-	-	-	-	-	-	-	-	-	-	2	-
36	-	-	-	-	-	-	-	-	-	-	-	-	1	-
37	-	-	-	-	-	-	-	-	-	-	-	-	1	-
38	-	-	-	-	-	-	-	-	-	-	-	-	1	-
39	-	-	-	-	-	-	-	-	-	-	-	-	1	-
40	-	-	-	-	-	-	-	-	-	-	-	-	1	-
45	-	-	-	-	-	-	-	-	-	-	-	-	1	-
	180	148	448	1049	1497	99	963	1532	648	391	1106	338	208	56

XI.—FLOUNDER.

Col.	I. Lochfyne,	5th July 1901.	Push-net.
"	II. "	10th Sept. 1900.	"
"	III. "	27th March 1901.	"
"	IV. "	16th April 1901.	"
"	V. "	23rd June 1903.	"
"	VI. "	13th July 1903.	"
"	VII. "	31st Aug. 1901.	"
"	VIII. Dornoch Firth,	25th May 1901.	"
"	IX. Annan,	23rd April 1900.	Shrimp-net.
"	X. "	24th May 1900.	"
"	XI. Dornoch Firth,	30th March 1904.	Otter-trawl.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.		
											Fem.	Male.	Total.
1	-	-	-	-	-	-	-	-	-	-	-	-	-
1.5	2	-	-	-	1	-	-	-	-	-	-	-	-
2	2	-	-	-	-	-	-	-	-	-	-	-	-
2.5	3	-	-	-	-	-	-	-	-	-	-	-	-
3	11	-	-	-	-	1	-	-	-	-	-	-	-
3.5	6	-	-	-	-	-	-	-	-	-	-	-	-
4	4	-	-	-	-	1	-	-	-	-	-	-	-
4.5	1	3	-	-	-	-	1	-	-	-	-	-	-
5	1	5	-	-	-	-	-	-	-	-	-	-	-
5.5	1	5	-	-	-	-	-	-	-	-	-	-	-
6	-	2	-	-	-	-	-	1	-	-	-	-	-
6.5	-	-	1	-	-	-	1	-	-	-	-	-	-
7	-	-	-	-	-	-	-	1	-	-	-	-	-
7.5	-	1	-	-	-	-	-	-	-	-	-	-	-
8	-	1	-	-	-	-	-	-	1	-	-	-	-
8.5	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	1	-	-	-	-
9.5	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	1	1	-	-	-	-	-	-	-	-	-
10.5	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	1	-	-	-
11.5	-	-	-	1	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-
12.5	-	-	-	-	-	-	-	-	-	-	-	-	-
13	-	-	-	1	-	-	-	-	-	-	-	-	-
13.5	-	-	-	-	-	-	-	-	1	-	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-
14.5	-	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	1	-	-	-	-	-	-	-
15.5	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	-	-	-	-
16.5	-	-	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	2	1	-	-	-	-
17.5	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	1	-	1	-	-	-
18.5	-	-	-	-	-	-	-	-	1	-	-	-	-
19	-	-	-	-	-	-	-	1	-	-	-	-	-
19.5	-	-	-	-	-	-	-	-	1	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	4	-	4
21	-	-	-	-	-	-	-	-	-	-	6	-	6
22	-	-	-	-	-	-	-	-	-	-	6	-	6
23	-	-	-	-	-	-	-	-	-	-	6	-	6
24	-	-	-	-	-	-	-	-	-	-	10	-	10
25	-	-	-	-	-	-	-	-	-	-	8	3	11
26	-	-	-	-	-	-	-	-	-	-	8	-	8
27	-	-	-	-	-	-	-	-	-	-	8	-	8
28	-	-	-	-	-	-	-	-	-	-	7	1	8
29	-	-	-	-	-	-	-	-	-	-	7	3	10
30	-	-	-	-	-	-	-	-	-	-	7	2	9
31	-	-	-	-	-	-	-	-	-	-	11	1	12
32	-	-	-	-	-	-	-	-	-	-	4	3	7
33	-	-	-	-	-	-	-	-	-	-	15	1	16
34	-	-	-	-	-	-	-	-	-	-	15	1	16
35	-	-	-	-	-	-	-	-	-	-	7	1	8
36	-	-	-	-	-	-	-	-	-	-	2	1	3
37	-	-	-	-	-	-	-	-	-	-	1	1	2
38	-	-	-	-	-	-	-	-	-	-	3	1	4
39	-	-	-	-	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	4	-	4
41	-	-	-	-	-	-	-	-	-	-	1	1	2
42	-	-	-	-	-	-	-	-	-	-	1	1	2
45	-	-	-	-	-	-	-	-	-	-	-	-	1
	31	17	2	3	1	3	2	6	5	3	136	23	159

XII.—LEMON DABS.  
ANNAN.

Cm.	2nd Sept. 1904.		9th Sept. 1904.		15th and 16th Sept. 1904.		Totals—2nd to 16th Sept. 1904.		22nd April 1905.		6th May 1905.		15th May 1905.		24th May 1905.		Total—May 1905.		25th Sept. 1905.											
	F. M.	Total.	F. M.	Total.	F. M.	Total.	F. M.	Total.	F. M.	Total.	F. M.	Total.	F. M.	Total.	F. M.	Total.	F. M.	Total.	F. M.	Total.										
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
6	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
7	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
8	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
9	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
10	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
11	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
12	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
13	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
14	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
15	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
16	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
17	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
18	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
19	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
20	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-									
	12	11	23	87	85	172	149	114	263	248	210	458	21	15	36	68	46	109	22	14	36	8	4	12	93	64	157	18	12	30

XIII.—LEMON DAB.

Col. I. Moray Firth and Aberdeen Bay, 8th-13th October 1900.  
 " II. " " " 31st October-9th November 1900.  
 " III. Totals of I. and II. " "  
 " IV. Near Fair Isle, October 1900.  
 " V. Aberdeen Bay, 8th October 1900.  
 " VI. " 31st October and 1st November 1900.  
 " VII. " 23rd October 1900.  
 " VIII. " November 1900.

Cm.	I.	II.	III.	IV.	V.			VI.			VII.			VIII.		
					F.	M.	TL.	F.	M.	TL.	F.	M.	TL.	F.	M.	TL.
9	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	1	1	-	-	1	1	2	-	-	-	-	-	-
12	-	1	1	-	3	-	3	1	1	1	1	1	2	-	-	-
5	-	-	-	-	-	-	-	1	-	1	1	1	2	-	-	-
13	-	3	3	-	-	-	-	1	1	1	-	-	-	1	-	1
5	-	1	1	1	1	-	-	1	1	1	2	-	2	1	1	1
14	1	2	3	-	1	1	2	-	-	-	1	1	1	-	-	-
5	1	1	2	-	-	1	1	1	1	1	-	-	-	-	-	-
15	1	3	4	1	1	-	-	1	-	1	2	-	2	-	-	-
5	-	8	8	1	-	-	-	2	-	2	-	1	1	-	-	-
16	-	9	9	1	-	-	-	-	-	-	2	2	1	-	-	-
5	1	7	8	-	-	-	-	2	-	2	1	1	1	1	-	1
17	1	9	10	2	-	-	-	4	-	4	1	-	1	-	-	-
5	2	12	14	2	-	1	1	-	-	-	-	-	-	-	-	-
18	5	13	18	3	-	-	-	1	-	1	-	-	-	-	-	-
5	12	12	24	3	1	-	1	-	-	-	-	-	-	-	-	-
19	9	11	20	-	-	-	-	-	-	-	3	-	3	-	-	-
5	3	3	6	-	1	-	1	-	-	-	1	1	2	-	-	-
20	9	6	15	2	-	-	-	-	-	-	-	-	-	-	-	-
5	8	6	14	1	-	-	-	-	-	-	1	1	1	-	-	-
21	16	7	23	4	1	-	1	-	-	-	-	-	-	-	-	-
5	9	7	16	3	-	-	-	-	-	-	1	1	2	-	-	-
22	10	9	19	-	-	-	-	1	-	1	1	1	2	-	-	-
5	5	4	9	-	-	-	-	-	-	-	1	-	1	-	-	-
23	13	6	19	1	-	-	-	-	-	-	-	-	-	-	-	-
5	5	5	10	1	-	-	-	-	-	-	-	-	-	-	-	-
24	4	7	11	-	-	-	-	-	-	-	2	2	-	-	-	-
5	8	3	11	2	-	-	-	1	1	1	-	1	-	-	-	-
25	2	4	6	2	-	-	-	-	-	-	-	-	-	-	-	-
5	5	6	11	-	-	-	-	-	-	-	-	-	-	-	-	-
26	6	3	9	2	1	-	1	-	-	-	-	-	-	-	-	-
5	1	5	6	1	-	-	-	-	-	-	-	-	-	-	-	-
27	4	1	5	1	-	-	-	-	-	-	-	-	-	-	-	-
5	2	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
28	3	2	5	1	-	-	-	-	-	-	-	-	-	-	-	-
5	1	5	6	-	-	-	-	-	-	-	-	-	-	-	-	-
29	2	4	6	2	-	-	-	-	-	-	-	-	-	-	-	-
5	4	3	7	1	-	-	-	-	-	-	-	-	-	-	-	-
30	5	7	12	1	-	-	-	-	-	-	-	-	-	-	-	-
5	4	3	7	2	1	-	1	-	-	-	-	-	-	-	-	-
31	6	1	7	3	-	-	-	-	-	-	-	-	-	-	-	-
5	6	1	6	-	-	-	-	-	-	-	2	-	2	-	-	-
32	4	3	7	1	-	-	-	-	-	-	-	-	-	-	-	-
5	5	-	5	2	-	-	-	-	-	-	-	-	-	-	-	-
33	11	-	11	6	-	-	-	-	-	-	-	-	-	-	-	-
5	9	2	11	2	-	-	-	-	-	-	-	-	-	-	-	-
34	17	2	19	1	-	-	-	-	-	-	-	-	-	-	-	-
5	14	-	14	5	-	-	-	-	-	-	-	-	-	-	-	-
35	14	2	16	7	-	-	-	-	-	-	-	-	-	-	-	-
5	17	-	17	6	-	-	-	-	-	-	-	-	-	-	-	-
36	24	2	26	9	-	-	-	-	-	-	-	-	-	-	-	-
5	23	5	28	8	-	-	-	-	-	-	-	-	-	-	-	-
37	12	2	14	8	-	-	-	-	-	-	-	-	-	-	-	-
5	15	2	17	7	-	-	-	-	-	-	-	-	-	-	-	-
38	11	-	11	12	-	-	-	-	-	-	-	-	-	-	-	-
5	9	1	10	12	-	-	-	-	-	-	-	-	-	-	-	-

## XIII.—LEMON DAB—continued.

Cm.	I.	II.	III.	IV.	V.			VI.			VII.			VIII.		
					F.	TL.		M.	F.	TL.	M.	F.	TL.	M.	F.	TL.
39	15	-	15	9	-	-	-	-	-	-	-	-	-	-	-	-
5	7	1	8	4	-	-	-	-	-	-	-	-	-	-	-	-
40	10	1	11	4	-	-	-	-	-	-	-	-	-	-	-	-
5	5	1	6	5	-	-	-	-	-	-	-	-	-	-	-	-
41	1	-	1	5	-	-	-	-	-	-	-	-	-	-	-	-
5	3	-	3	4	-	-	-	-	-	-	-	-	-	-	-	-
42	6	-	6	7	-	-	-	-	-	-	-	-	-	-	-	-
5	5	1	6	2	-	-	-	-	-	-	-	-	-	-	-	-
43	1	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
5	1	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	412	227	639	182	9	3	12	14	6	20	18	12	30	2	1	3

## XIV.—LEMON DAB.

Col. IX.	Aberdeen Bay,	6th June 1901.	Col. XVII.	Firth of Forth, III.,	23rd July 1901.
" X.	"	30th July 1901.	" XVIII.	"	V., 24th July 1901.
" XI.	"	31st July 1901.	" XIX.	"	V., August 1901.
" XII.	"	21st August 1901.	" XX.	Smith Bank, Moray Firth,	23rd Oct. 1901.
" XIII.	"	10th September 1901.	" XXI.	"	8th Nov. 1901.
" XIV.	"	28th November 1901.	" XXII.	"	27th Dec. 1901.
" XV.	"	17th December 1901.	" XXIII.	Dornoch Firth,	22nd Oct. 1903.
" XVI.	Firth of Forth, III.,	May 1901.			

Cm.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.				XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
								Fem.	Male.	♀	Total.							
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	1	-	-	1	-	1	1	-	-	-	-
5	-	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-
11	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	1	-	2	-	-	-	-	1	-	1	2	-	-	-	-	-	-
12	-	-	-	1	-	-	-	1	-	-	1	1	-	-	-	-	-	-
5	-	-	1	1	-	-	-	-	-	-	1	-	-	2	-	-	-	-
13	-	1	-	1	-	-	-	-	1	-	1	-	-	2	-	-	-	-
5	-	-	1	1	1	-	-	-	-	-	-	2	-	-	3	-	-	1
14	-	-	1	1	-	-	-	2	-	-	2	1	-	1	-	1	-	1
5	-	-	-	1	-	-	-	1	3	-	4	3	-	1	2	1	-	1
15	-	-	-	-	-	-	-	4	1	1	6	-	1	1	2	1	-	-
5	-	-	1	1	-	-	-	2	-	-	2	1	-	-	-	1	-	-
16	-	-	-	1	-	-	-	4	1	-	5	-	1	1	2	-	-	-
5	-	-	-	-	-	-	-	5	1	-	6	3	-	2	-	-	-	-
17	-	-	-	2	-	-	-	-	-	1	1	-	-	-	-	-	-	-
5	-	-	1	4	-	-	-	1	-	-	1	-	-	-	2	-	-	-
18	-	-	-	6	-	-	-	-	-	-	-	-	-	2	-	-	-	-
5	-	1	-	1	-	-	-	1	-	-	1	1	-	1	-	-	-	-
19	-	2	-	1	1	-	-	-	-	-	-	1	-	2	-	2	-	-
5	-	-	-	4	-	-	-	-	-	1	1	2	-	3	-	3	-	-

XIV.—LEMON DAB—continued.

Cm.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.				XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.
								Male.	Fem.	?	Total.							
20	-	1	-	7	-	-	-	-	-	-	-	2	-	3	-	2	-	-
20.5	-	1	2	3	-	-	-	1	-	-	1	-	-	3	-	-	-	-
21	-	-	-	3	-	-	1	1	-	1	2	2	-	3	-	1	-	-
21.5	-	-	-	5	-	-	-	-	-	-	-	2	-	-	-	-	-	-
22	-	-	-	1	-	-	-	1	-	-	1	1	-	3	-	-	-	-
22.5	-	-	-	2	-	-	-	-	-	-	-	1	-	1	-	-	1	-
23	-	2	1	2	-	-	-	-	-	-	-	1	-	1	-	-	-	-
23.5	-	-	-	1	-	1	-	1	1	-	2	-	-	-	-	-	-	-
24	1	-	-	4	-	-	-	-	3	-	3	-	-	1	-	-	-	-
24.5	-	2	-	1	-	-	-	2	1	1	3	2	-	-	-	-	-	-
25	1	-	-	1	-	-	1	2	-	-	4	1	-	-	1	-	1	-
25.5	1	-	-	3	1	-	-	2	2	-	-	1	-	-	-	-	-	-
26	-	-	-	5	-	1	-	1	-	2	3	2	-	-	-	-	-	-
26.5	-	3	-	1	-	-	-	1	-	-	1	-	-	-	-	-	-	-
27	1	-	-	3	1	-	-	1	-	3	3	2	-	-	-	-	-	-
27.5	-	2	-	8	1	-	1	1	-	-	1	-	-	-	1	-	-	-
28	-	-	-	2	-	-	-	-	1	2	3	-	-	1	-	-	2	-
28.5	-	-	-	5	2	-	-	1	1	1	3	-	-	-	-	-	-	-
29	1	3	-	2	-	-	-	2	-	-	2	-	1	-	-	-	-	-
29.5	-	3	-	1	-	-	-	1	1	-	2	-	-	-	-	-	-	-
30	-	2	-	1	-	-	1	-	-	-	1	-	-	-	-	-	-	-
30.5	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31	-	4	-	3	1	1	1	-	-	-	-	-	-	-	-	1	-	-
31.5	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	-	4	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-
32.5	1	2	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33	1	-	1	1	-	-	1	-	-	-	-	-	-	-	-	1	-	-
33.5	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34.5	-	4	-	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-
35	-	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
35.5	-	2	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-
36	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
36.5	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
37	-	4	-	1	-	-	1	-	-	-	-	-	-	-	-	-	1	-
37.5	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	1	-
38	-	5	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1	-
38.5	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
39	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
39.5	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
40	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40.5	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
41.5	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42.5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
43	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
43.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10	89	9	118	10	5	10	37	18	13	68	37	4	35	20	15	13	3

XV.—LEMON DAB.

Col. XXIV. Dornoch Firth, Moray Firth, 11th November 1901.  
" XXV. Off Lybster, " 22nd " 1903.  
" XXVI. Firth of Clyde, 5th September 1899.  
" XXVII. " 4th October 1899.  
" XXVIII. " 5th " "

Cm.	XXIV.	XXV.	XXXVI.				XXVII.	XXVIII.			
			Fem.	Male.	?	Total.		Fem.	Male.	?	Total.
8	-	-	-	-	-	-	-	-	-	-	-
8.5	-	-	-	-	-	-	1	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-
9.5	-	-	-	-	-	-	2	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-
10.5	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	1	1	-	-	-	-	-
11.5	-	-	-	-	1	1	-	-	-	-	-
12	-	-	1	-	1	2	2	-	-	-	-
12.5	-	-	1	1	-	2	-	-	1	-	1
13	-	-	2	2	1	5	-	-	3	-	3
13.5	-	-	6	3	2	11	2	-	1	1	2
14	-	-	2	2	-	4	-	2	4	-	6
14.5	1	-	1	1	1	3	-	2	-	1	3
15	-	-	5	-	-	5	-	-	2	-	2
15.5	1	-	2	1	1	4	-	-	1	-	1
16	1	-	6	3	-	9	-	1	4	1	6
16.5	2	-	5	2	-	7	-	2	-	1	3
17	-	-	7	-	-	7	-	1	-	-	1
17.5	-	-	1	1	-	2	-	2	1	-	3
18	1	-	2	-	-	2	-	3	-	-	3
18.5	-	-	-	1	-	1	-	3	1	-	4
19	-	-	-	-	-	-	-	4	-	-	4
19.5	-	-	-	-	-	-	-	-	-	-	-
20	1	-	2	-	1	3	-	-	1	-	1
20.5	-	-	-	-	-	-	-	-	-	-	-
21	-	-	2	1	-	3	-	1	-	-	1
21.5	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-
22.5	-	-	-	1	-	1	-	-	-	-	-
23	-	-	-	1	-	1	-	-	-	-	-
23.5	-	-	-	-	-	-	-	1	-	-	1
24	-	-	-	-	-	-	-	-	1	-	1
24.5	-	-	-	-	-	-	-	1	-	-	1
25	-	-	-	-	-	-	-	-	-	-	-
25.5	-	-	1	-	-	1	-	-	1	-	1
26	-	-	-	-	-	-	-	-	-	-	-
26.5	-	-	1	-	-	1	-	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-
27.5	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-
28.5	-	-	1	-	-	1	-	-	-	-	-
29	-	-	-	-	-	-	-	-	-	-	-
29.5	-	1	1	-	-	1	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-
30.5	-	-	-	-	-	-	-	-	-	-	-
31	-	1	-	-	-	-	-	-	-	-	-
31.5	-	1	-	-	-	-	-	-	-	-	-
32	-	-	1	-	-	1	-	-	-	-	-
32.5	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	-
33.5	-	-	-	-	-	-	-	-	-	-	-
34	-	-	-	-	-	-	-	-	-	-	-
34.5	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-
35.5	-	-	-	-	-	-	-	-	-	-	-
36	-	-	-	-	-	-	-	-	-	-	-
36.5	-	-	-	-	-	-	-	-	-	-	-
37	-	-	-	-	-	-	-	-	-	-	-
37.5	-	-	-	-	-	-	-	-	-	-	-
38	-	1	-	-	-	-	-	-	-	-	-
38.5	-	1	-	-	-	-	-	-	-	-	-
	7	5	50	20	9	79	7	23	21	4	48



## XVI.—LONG ROUGH DAB.

[illegible]



XVII.—TURBOT—continued.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.
32	-	-	-	-	-	-	-	-	-	-	-	-	-
32.5	-	-	-	-	-	-	-	-	-	-	-	-	-
33	-	-	-	-	-	-	-	-	-	-	1	1	-
33.5	-	-	-	-	-	-	-	1	1	1	-	1	-
34	-	-	-	-	-	-	-	1	-	1	1	2	-
34.5	-	-	-	-	-	-	-	-	-	-	-	-	-
35	-	-	-	-	-	-	-	-	-	-	-	-	-
35.5	-	-	-	-	-	-	-	-	-	1	-	1	-
36	-	-	-	-	-	-	-	-	1	3	2	5	-
36.5	-	-	-	-	-	-	-	-	1	2	1	3	-
37	-	-	-	-	-	-	-	-	-	3	2	5	1
37.5	-	-	-	-	-	-	-	1	-	1	-	1	1
38	-	-	-	-	-	-	-	2	-	-	2	2	-
38.5	-	-	-	-	-	-	-	2	-	1	1	2	1
39	-	-	-	-	-	-	-	1	-	1	-	1	2
39.5	-	-	-	-	-	-	-	-	-	2	-	2	-
40	-	-	-	-	-	-	-	-	-	-	-	-	1
40.5	-	-	-	-	-	-	-	-	-	2	-	2	1
41	-	-	-	-	-	-	-	-	-	-	-	-	2
41.5	-	-	-	-	-	-	-	-	-	1	1	2	-
42	-	-	-	-	-	-	-	-	-	-	-	-	-
42.5	-	-	-	-	-	-	-	-	-	-	-	-	2
43	-	-	-	-	-	-	-	-	-	1	-	1	-
43.5	-	-	-	-	-	-	-	-	-	1	-	1	-
44	-	-	-	-	-	-	-	1	-	1	2	3	-
44.5	-	-	-	-	-	-	-	-	-	2	-	2	-
45	-	-	-	-	-	-	-	-	-	4	3	7	4
46	-	-	-	-	-	-	-	-	-	-	-	-	2
47	-	-	-	-	-	-	-	-	-	1	-	1	1
48	-	-	-	-	-	-	-	-	-	1	-	1	-
49	-	-	-	-	-	-	-	-	-	2	-	2	-
50	-	-	-	-	-	-	-	-	-	1	-	1	2
51	-	-	-	-	-	-	-	-	-	-	-	-	-
52	-	-	-	-	-	-	-	-	-	-	1	1	-
53	-	-	-	-	-	-	-	-	-	-	-	-	-
54	-	-	-	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	-	-	-	-	-
56	-	-	-	-	-	-	-	-	-	-	-	-	-
57	-	-	-	-	-	-	-	-	-	-	-	-	-
58	-	-	-	-	-	-	-	-	-	-	-	-	-
59	-	-	-	-	-	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-	-	-	-	-	-
61	-	-	-	-	-	-	-	-	-	-	-	-	1
62	-	-	-	-	-	-	-	-	-	-	-	-	-
63	-	-	-	-	-	-	-	-	-	-	-	-	-
64	-	-	-	-	-	-	-	-	-	-	-	-	-
65	-	-	-	-	-	-	-	-	-	-	-	-	1
66	-	-	-	-	-	-	-	-	-	-	-	-	-
67	-	-	-	-	-	-	-	-	-	-	-	-	-
68	-	-	-	-	-	-	-	-	-	-	-	-	-
69	-	-	-	-	-	-	-	-	1	-	-	-	-
70	-	-	-	-	-	-	-	-	-	-	1	1	-
71	-	-	-	-	-	-	-	-	-	-	-	-	-
72	-	-	-	-	-	-	-	-	-	-	-	-	-
73	-	-	-	-	-	-	-	-	-	-	-	-	-
74	-	-	-	-	-	-	-	-	-	-	-	-	-
75	-	-	-	-	-	-	-	-	-	-	-	-	-
76	-	-	-	-	-	-	-	-	-	-	-	-	-
77	-	-	-	-	-	-	-	-	-	-	-	-	-
78	-	-	-	-	-	-	-	-	-	-	-	-	-
79	-	-	-	-	-	-	-	-	-	-	-	-	-
80	-	-	-	-	-	-	-	-	1	-	-	-	-
	8	1	1	30	17	5	11	9	5	33	19	52	22

## XVIII—BRILL.

Col.	I.	Aberdeen Bay, 18th September 1901.	Push-net on beach.
"	II.	Annan, 30th April 1900.	Shrimp-net.
"	III.	Montrose, May.	Stake-nets.
"	IV.	" June.	"
"	V.	" July.	"
"	VI.	Burghead Bay, Moray Firth, 9th, 10th November 1903.	
"	VII.	" " "	25th, 26th December "
"	VIII.	" " "	21st-27th November 1904.
"	IX.	" " "	6th-12th December 1904.
"	X.	Totals of VIII. and IX.	
"	XI.	Burghead Bay, Moray Firth, 6th and 7th February 1905.	
"	XII.	Dornoch Firth, "	9th November 1901.
"	XIII.	" "	10th, 11th November 1903.
"	XIV.	" "	25th, 26th December "
"	XV.	Aberdeen Bay, 6th, 7th June 1901.	

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.
3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
3.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-
8.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
11.5	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
12	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
12.5	-	-	4	1	1	-	-	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-
14.5	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
15	-	-	5	4	1	-	-	-	-	-	-	-	-	-	-
15.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
16.5	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-
18.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20.5	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
21.5	-	-	1	-	-	-	-	1	2	3	-	-	-	-	-
22	-	-	-	-	-	-	-	1	1	1	1	-	-	-	-
22.5	-	-	1	-	-	-	-	1	1	2	2	-	-	-	-
23	-	-	2	2	-	-	-	1	3	4	-	-	-	-	-
23.5	-	-	2	1	-	-	-	1	1	2	1	2	-	-	-
24	-	-	2	1	1	-	-	1	-	1	-	-	-	-	-
24.5	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-
25	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-
25.5	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-
26	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-
26.5	-	-	-	-	-	1	1	1	-	1	-	-	1	-	-
27	-	-	-	-	-	1	-	1	-	-	-	-	-	1	-
27.5	-	-	-	-	-	1	-	1	1	2	-	2	-	1	-
28	-	-	-	-	-	3	1	-	2	4	-	-	-	1	-
28.5	-	-	1	-	-	3	-	2	2	4	1	-	-	2	-
29	-	-	-	-	-	6	-	1	2	3	-	-	-	1	-
29.5	-	-	-	-	-	1	1	-	-	-	1	-	-	1	-

XVIII.—BRILL—continued.

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.
30	-	-	-	-	-	4	1	1	1	2	-	-	1	1	-
31	-	-	-	-	-	2	1	-	2	2	1	-	1	3	-
32	-	-	-	-	-	5	-	3	1	4	3	-	-	4	-
33	-	-	-	-	-	6	1	-	-	-	-	2	-	3	-
34	-	-	-	-	-	5	-	2	2	4	1	1	-	6	1
35	-	-	-	-	-	5	1	2	1	3	4	1	-	2	-
36	-	-	-	-	-	3	2	-	-	-	1	1	1	2	-
37	-	-	-	-	-	1	1	-	1	1	-	1	-	2	-
38	-	-	-	-	-	1	1	1	2	3	-	-	1	2	-
39	-	-	-	-	-	-	1	2	1	3	1	-	-	-	2
40	-	-	-	-	-	1	-	3	3	6	1	1	-	1	1
41	-	-	-	-	-	2	-	6	2	8	1	3	-	-	1
42	-	-	-	-	-	5	-	6	4	10	1	1	-	2	-
43	-	-	-	-	-	1	-	12	9	21	5	2	1	-	2
44	-	-	-	-	-	3	-	17	6	23	5	1	-	1	1
45	-	-	-	-	-	2	-	15	9	24	12	2	-	-	5
46	-	-	-	-	-	2	-	17	8	25	13	1	-	1	-
47	-	-	-	-	-	3	-	17	6	23	14	2	-	1	1
48	-	-	-	-	-	3	-	10	18	28	8	-	-	-	2
49	-	-	-	-	-	3	1	12	13	25	13	1	-	-	-
50	-	-	-	-	-	1	-	17	9	26	11	2	-	-	-
51	-	-	-	-	-	2	-	10	6	16	15	-	-	-	-
52	-	-	-	-	-	1	1	12	8	20	12	-	-	1	-
53	-	-	-	-	-	2	-	2	1	3	9	-	-	1	1
54	-	-	-	-	-	2	2	5	7	12	5	-	-	-	-
55	-	-	-	-	-	2	-	3	4	7	11	2	1	1	-
56	-	-	-	-	-	1	1	3	2	5	2	-	-	-	-
57	-	-	-	-	-	-	-	2	3	5	4	-	-	-	-
58	-	-	-	-	-	-	1	3	3	5	2	-	-	1	-
59	-	-	-	-	-	-	-	5	2	7	4	-	-	-	-
60	-	-	-	-	-	-	-	1	3	4	2	-	-	-	-
61	-	-	-	-	-	-	-	1	1	2	1	-	-	1	-
62	-	-	-	-	-	-	2	1	-	4	2	1	-	-	1
	6	1	30	16	7	85	20	212	156	368	171	30	8	47	18

XIX.—COD—ABERDEEN BAY.

Col. I.	15th January 1902.	Col. XV.	XII.—XIV. combined.
„ II.	11th February 1905.	„ XVI.	10th September 1901.
„ III.	29th March 1905.	„ XVII.	18th October 1901.
„ IV.	13th May 1902.	„ XVIII.	31st October 1903.
„ V.	13th June 1901.	„ XIX.	5th November 1901.
„ VI.	28th June 1901.	„ XX.	6th November 1901.
„ VII.	30th July 1901.	„ XXI.	XIX. and XX. combined.
„ VIII.	31st July 1901.	„ XXII.	28th November 1901.
„ IX.	VII. and VIII. combined.	„ XXIII.	29th November 1901.
„ X.	21st August 1901.	„ XXIV.	XXII. and XXIII. combined.
„ XI.	3rd September 1901.	„ XXV.	12th December 1904.
„ XII.	4th September 1901.	„ XXVI.	16th December 1901.
„ XIII.	4th September 1901.	„ XXVII.	29th December 1903.
„ XIV.	4th September 1901.		

Cm.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	XXVI.
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	
6	-	-	-	-	-	-	1	-	-	6	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	
7	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	6	2	-	-	-	-	-	1	1	-	2
8	-	3	-	-	-	-	-	-	-	7	-	-	-	1	1	6	9	1	-	1	1	-	5	5	-	2
9	2	6	1	-	-	-	-	-	-	-	-	-	-	-	-	8	10	4	-	26	26	-	7	7	-	3
10	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4	2	-	36	36	-	10	10	-	3
11	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	5	10	4	-	50	50	-	6	6	-	3
12	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	12	2	-	47	47	-	1	1	-	2
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	6	2	-	39	39	-	1	1	-	-
14	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	10	2	-	38	38	-	-	-	-	1
15	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	1	4	3	-	21	21	-	1	1	-	2
16	1	-	2	1	2	-	1	1	2	-	-	-	-	-	-	-	5	-	-	22	22	-	-	-	-	-
17	-	1	-	-	5	-	1	-	1	-	-	-	-	-	-	-	1	-	-	11	11	-	1	1	-	-
18	-	-	-	-	8	-	-	1	1	2	1	-	-	-	-	1	-	-	-	9	9	1	2	3	-	-
19	-	-	2	1	6	3	1	7	8	3	1	-	-	1	1	-	2	-	-	1	1	-	1	1	-	1
20	-	-	-	1	3	3	5	1	6	2	1	-	1	1	2	-	-	-	-	-	-	-	1	1	-	1
21	-	-	-	-	2	6	3	4	7	15	7	-	3	4	7	-	-	-	-	-	-	-	2	2	-	-
22	-	-	-	-	2	2	7	1	8	19	6	1	1	-	2	1	1	1	-	-	-	-	2	2	-	-
23	-	-	-	-	1	2	7	6	13	15	9	1	2	3	6	-	2	2	-	-	-	1	1	2	-	1
24	-	-	-	-	-	2	7	2	9	8	11	2	2	3	7	2	-	-	-	-	-	1	1	2	-	1
25	-	-	-	-	-	-	4	4	8	12	20	4	6	5	15	-	2	2	-	-	-	1	1	2	-	5
26	1	-	-	-	-	1	4	3	7	3	12	1	3	2	6	-	8	2	2	-	2	-	4	4	-	7
27	1	-	-	1	-	-	2	2	4	2	10	1	2	5	8	1	6	2	2	-	2	1	9	10	-	5
28	1	-	-	-	-	-	1	-	1	1	9	1	3	4	8	1	3	-	2	-	2	4	6	10	-	6
29	2	-	-	-	-	1	1	-	1	2	4	1	1	1	3	1	3	1	3	-	3	3	14	17	-	6
30	3	-	-	1	-	-	3	-	3	-	-	-	-	-	-	-	4	-	5	-	5	1	15	16	-	8
31	-	-	-	2	-	-	3	-	3	-	1	1	-	-	1	-	1	-	2	-	2	6	20	26	1	4
32	1	-	-	-	-	-	-	1	1	1	1	1	-	-	1	-	2	1	2	-	2	6	16	22	-	11
33	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	5	16	21	1	4
34	1	-	-	1	-	-	1	-	1	-	-	-	-	-	-	-	1	-	1	-	1	3	9	12	-	3
35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	1	5	7	12	1	1

XIX.—COD—ABERDEEN BAY—continued.

II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	XV.	XVI.	XVII.	XVIII.	XIX.	XX.	XXI.	XXII.	XXIII.	XXIV.	XXV.	XXVI.	XXVII.
-	-	-	-	1	1	-	1	1	-	-	-	-	-	-	-	1	-	-	-	4	5	9	19	24	-
-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	5	6	1	-	-
-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	2	3	26	24	-
-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-	1	-	-	-	1	3	4	10	-	-
-	-	-	-	-	5	-	6	1	-	-	-	-	-	-	-	-	-	-	-	1	2	2	12	-	-
-	-	-	1	-	7	-	7	1	1	-	-	-	-	-	-	-	-	-	-	1	2	3	16	12	-
-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	1	-	-
-	-	-	-	-	2	-	2	1	1	-	-	-	-	-	-	-	-	-	-	1	4	5	1	-	-
-	-	-	-	-	1	-	1	-	2	-	-	-	-	-	-	1	-	-	-	1	2	3	12	-	-
-	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-
-	-	-	-	-	1	-	1	2	-	-	-	-	-	-	-	-	1	-	1	-	-	-	4	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	2	1	1	2	12	-	-
-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1	-	1	-	1	1	4	-	-
-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	2	3	4	-	-
-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	2	-	-
-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	2	-	2	4	-	-
-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-
-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	1	-	1	-	1	-	1	1	-	-	-
-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-
-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
16	6	10	32	27	72	33	104	120	107	14	24	30	63	48	114	40	27	301	328	56	193	249	51	89	5

## XX.—COD.

## DORNOCH FIRTH.

- Col. I. 9th February 1905.  
 „ II. 22nd October 1903.  
 „ III. 9th, 10th November 1901.  
 „ IV. 12th November 1903.  
 „ V. 7th December 1904.  
 „ VI. 19th December 1901.

## SMITH BANK.

- Col. I. 1st April 1904.  
 „ II. 23rd October 1903.

## SMITH BANK—continued.

- Col. III. 8th November 1901.  
 „ IV. 27th December 1903.

## BURGHREAD BAY.

- Col. I. 7th September 1901.  
 „ II. 20th October 1903.  
 „ III. 6th December 1904.  
 „ IV. 20–25th December 1901.  
 „ V. 29th December 1903.

Cm.	DORNOCH FIRTH.						SMITH BANK.				BURGHREAD BAY.				
	I.	II.	III.	IV.	V.	VI.	I.	II.	III.	IV.	I.	II.	III.	IV.	V.
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-
8	1	-	-	-	-	3	-	1	-	-	-	-	-	-	-
9	2	2	-	-	5	-	-	-	1	-	-	-	-	-	-
10	2	-	5	-	2	-	-	-	1	-	1	1	-	1	-
11	-	-	13	-	1	-	-	-	-	-	1	1	-	3	-
12	-	-	18	1	-	-	1	1	1	-	1	-	-	8	-
13	1	-	15	-	-	-	1	-	1	-	-	-	-	8	-
14	-	-	8	-	-	-	-	-	-	-	-	-	-	13	-
15	-	-	9	1	-	-	1	-	-	-	1	-	-	22	-
16	1	-	3	-	-	-	-	-	-	-	-	-	-	10	-
17	-	-	2	1	-	-	-	-	-	-	-	-	-	11	-
18	-	-	1	-	-	-	-	-	-	-	-	-	-	6	-
19	-	-	1	-	-	-	-	-	-	-	-	-	-	2	-
20	-	-	1	1	-	-	1	-	-	-	1	1	-	3	-
21	-	1	2	-	-	-	-	-	-	-	2	2	2	4	-
22	-	-	4	-	-	-	2	1	-	-	2	-	-	1	-
23	-	-	8	-	-	-	-	-	-	-	5	-	3	5	-
24	-	-	12	-	-	-	2	-	-	-	7	2	4	13	-
25	-	-	18	1	1	1	2	1	1	2	8	2	5	10	-
26	-	-	10	-	-	1	1	1	3	3	3	3	4	22	1
27	-	-	10	-	1	1	4	-	2	3	1	1	4	21	2
28	-	-	8	1	-	2	5	-	3	4	3	3	4	13	-
29	-	-	9	1	-	2	1	-	7	3	1	2	2	19	2
30	-	-	14	-	-	6	1	1	5	5	1	1	1	17	-
31	-	1	4	1	-	5	1	-	5	3	1	-	-	11	-
32	-	-	4	-	-	4	1	-	5	4	1	-	2	5	-
33	-	-	2	1	-	8	-	-	5	2	-	-	1	8	-
34	-	-	4	1	-	4	1	-	1	2	-	-	-	7	-
35	-	-	1	-	-	2	-	-	1	1	-	-	-	10	-
36	-	-	2	-	-	1	2	1	1	-	-	-	-	7	-
37	-	-	-	-	-	-	-	-	1	1	-	-	-	4	-
38	-	-	-	-	-	-	1	-	-	-	-	-	-	4	-
39	-	-	-	-	-	2	-	1	1	-	-	-	-	2	2
40	-	-	-	-	-	1	-	-	1	-	-	-	-	1	-
41	-	-	-	-	-	1	-	-	-	-	-	-	-	2	-
42	-	1	-	-	-	-	-	-	-	-	-	-	-	2	-
43	-	-	1	-	-	-	-	-	-	-	-	-	-	3	1
44	-	-	-	1	-	-	-	-	-	-	-	-	-	3	1
45	-	1	-	-	-	-	-	-	-	1	-	-	-	2	1
46	-	-	-	-	-	1	1	-	-	1	-	-	-	3	-
47	-	1	-	-	-	-	1	-	-	-	-	-	-	1	-
48	-	-	-	1	-	3	1	-	-	-	1	-	-	3	-
49	-	-	1	2	-	3	-	-	1	-	-	-	-	3	-
50	-	-	1	-	-	-	-	-	-	1	-	-	-	1	-
51	-	-	-	1	-	1	-	-	-	-	-	-	-	2	-
52	-	-	1	3	-	1	1	-	-	-	-	-	-	2	-
53	-	-	-	1	-	1	-	-	-	-	-	-	-	3	-
54	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
55	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
56	-	-	-	1	-	1	-	-	-	-	-	-	-	3	-
57	-	-	-	1	-	2	1	-	-	-	-	-	-	1	-
58	-	-	-	1	-	-	1	-	-	-	-	-	-	1	-
59	-	-	-	1	-	-	1	-	-	-	-	-	-	1	-
60	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
61	-	-	-	2	-	-	-	-	-	-	-	-	-	2	-
62	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
	7	8	192	26	15	56	38	10	47	36	35	21	32	311	11



XXI.—COD.

CROMARTY FIRTH.  
7th January 1901.

SINCLAIR BAY.  
4th June 1901.

OFF LYBSTER.  
Col. I. 22nd October 1903.  
„ II. 8th November 1901.

OFF DUNBEATH.

Col. I. 17th January 1902.  
„ II. & III. 18th January 1902.  
„ IV. I.-III. combined.

FIRTH OF FORTH.

Col. I.—Station III. 13-16th May 1901.  
„ II. „ 23rd July 1901.  
„ III. „ 22nd August 1901.  
„ IV.—Station V. 16th August 1901.

OFF SHETLAND.  
19-22nd May 1901.

Cm.	CROMARTY FIRTH.	SINCLAIR BAY.	OFF LYBSTER.		OFF DUNBEATH.				FIRTH OF FORTH.				OFF SHETLAND.		
			I.	II.	I.	II.	III.	IV.	Stations III.			V.			
									I.	II.	III.	IV.			
4	-	-	-	-	-	-	-	-	-	1	-	-	-	-	
5	-	-	1	-	-	-	-	-	-	14	1	-	-	-	
6	-	-	1	-	-	-	-	-	-	7	10	5	-	-	
7	-	-	-	-	-	-	-	-	-	5	14	5	-	-	
8	1	-	-	-	-	-	-	-	-	2	8	-	-	-	
9	1	-	2	-	-	-	-	-	2	7	-	-	-	-	
10	-	-	1	-	-	-	-	-	6	-	2	-	-	-	
11	-	-	-	-	-	-	-	-	13	-	1	-	-	-	
12	-	-	-	-	-	-	-	-	21	-	1	-	-	-	
13	-	-	-	-	-	-	1	1	24	-	2	-	-	-	
14	-	-	1	-	-	-	-	-	21	-	-	-	-	-	
15	1	-	-	-	-	-	-	-	18	2	-	-	-	-	
16	-	-	-	-	-	-	1	1	9	1	1	-	-	-	
17	1	-	-	-	-	-	-	-	5	6	1	-	-	-	
18	1	-	-	-	1	1	-	2	8	6	1	2	1	-	
19	3	-	-	-	-	-	2	2	6	10	6	-	-	-	
20	2	-	-	-	2	1	-	3	4	11	3	-	-	1	
21	5	-	-	-	1	-	3	4	3	9	13	-	-	-	
22	1	-	-	-	-	3	1	4	3	7	3	6	-	-	
23	-	-	-	-	1	2	1	4	1	6	3	3	1	-	
24	-	-	1	-	2	3	5	10	-	4	5	1	-	-	
25	1	-	-	-	7	2	6	15	1	3	4	2	2	-	
26	-	1	-	1	12	2	10	24	1	2	2	3	1	-	
27	1	-	-	-	8	2	11	21	1	3	4	-	5	-	
28	2	4	-	2	6	8	18	32	-	4	1	1	19	-	
29	3	3	-	6	4	4	13	21	-	2	-	1	23	-	
30	-	2	-	13	5	1	22	28	-	1	-	-	25	-	
31	2	1	1	20	6	2	26	34	-	-	-	-	33	-	
32	3	1	1	26	5	5	10	20	-	1	-	-	38	-	
33	1	3	-	23	3	-	11	14	-	1	-	-	33	-	
34	1	3	-	9	9	-	7	16	-	-	-	-	33	-	
35	3	1	-	8	4	1	3	8	-	-	-	-	19	-	
36	1	1	-	5	1	-	7	8	-	-	-	-	14	-	
37	1	-	-	1	3	-	4	7	-	-	-	-	5	-	
38	2	-	-	-	1	-	3	4	-	-	-	-	6	-	
39	1	-	-	-	3	-	5	8	-	-	-	-	8	-	
40	-	1	-	-	3	-	3	6	-	-	-	-	2	-	
41	-	-	-	-	1	-	-	1	-	-	-	-	4	-	
42	-	1	-	-	2	-	1	3	-	-	-	-	6	-	
43	-	1	-	-	2	-	-	2	-	-	-	-	6	-	
44	-	-	-	-	1	-	1	2	-	-	-	-	10	-	
45	-	2	-	-	1	-	1	2	-	-	-	-	4	-	
46	-	1	-	-	-	-	-	-	-	-	-	-	8	-	
47	-	-	-	-	2	-	-	2	-	-	-	-	7	-	
48	-	-	-	-	-	-	1	1	-	-	-	-	10	-	
49	-	-	-	-	-	-	-	-	-	-	-	-	7	-	
50	-	1	-	-	3	-	-	3	-	-	-	-	10	-	
51	-	2	-	-	1	-	-	1	-	-	-	-	9	-	
52	-	1	-	-	1	-	-	1	-	-	-	-	8	-	
53	-	1	-	-	7	-	-	7	-	-	-	-	7	-	
54	-	-	-	-	3	-	-	3	-	-	-	-	7	-	
55	-	1	-	-	-	-	-	-	-	-	-	-	9	-	
56	-	1	-	-	1	-	-	1	-	-	-	-	6	-	
57	-	-	-	-	1	-	-	1	-	-	-	-	6	-	
58	-	-	-	-	3	-	1	4	-	-	-	-	6	-	
59	-	-	-	-	3	-	-	3	-	-	-	-	2	-	
60	-	-	-	-	-	-	1	1	-	-	-	-	6	-	
61	-	-	-	-	-	-	1	1	-	-	-	-	4	-	
62	-	-	-	-	2	-	-	2	-	-	-	-	1	-	
			38	33	9	114	121	37	180	338	147	108	93	28	412

## XXII.—HADDOCK.

## ABERDEEN BAY.

- Col. I. 15th January 1902. (Doghole) 57 fms.  
 „ II. 29th March 1905.  
 „ III. 13th May 1902. (Doghole) 55 fms.  
 „ IV. 29th December 1903.  
 „ V. 31st October 1903.

## SMITH BANK.

- Col. I. 1st April 1904. (22 fathoms.)  
 „ II. 22nd October 1903.  
 „ III. 14th November 1903.  
 „ IV. 12th December 1904. (19-22 fathoms.)

## DOERNOCH FIRTH.

- Col. I. 22nd October 1903.  
 „ II. 13th November 1903.  
 „ III. 27th December 1903.

WITCH GROUND, OFF KINNAIRD HEAD.  
 23rd January 1904. (40-50 fathoms.)

## BURGH HEAD BAY.

- Col. I. 20th October 1903.  
 „ II. 29th December 1903.

OFF LYBSTER.—22nd October 1903.

Cm.	ABERDEEN BAY.								SMITH BANK.				DORNOCH FIRTH.			WITCH GROUND.	BURGH HEAD BAY.		OFF LYBSTER.
	I.	II.	III.	IV.	V.				I.	II.	III.	IV.	I.	II.	III.				
					F.	M.	?	Total											
10	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3	-	-
11	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	4	-	-
12	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	10	-	2
13	-	1	-	-	-	-	-	2	-	-	-	2	2	-	-	-	3	-	-
14	-	4	1	4	-	-	-	14	3	1	6	2	1	-	-	-	5	-	-
15	26	43	1	10	-	-	-	67	1	1	83	1	1	-	-	12	4	3	-
16	96	82	7	17	-	-	-	122	3	-	256	-	3	-	-	20	1	2	-
17	241	104	31	24	-	-	-	94	5	-	262	-	-	-	-	8	-	1	-
18	248	61	95	23	-	-	-	41	8	-	128	-	1	-	-	2	-	1	-
19	139	15	183	14	-	-	-	15	2	-	14	-	-	-	-	-	-	1	-
20	24	4	147	2	-	-	-	5	1	1	-	-	-	-	-	-	-	1	-
21	1	-	87	3	-	-	-	3	8	2	-	-	1	-	-	2	-	-	1
22	-	-	25	2	-	-	-	8	8	20	17	-	-	-	-	5	-	-	2
23	-	-	9	1	-	-	-	13	14	40	49	-	-	-	-	27	13	8	6
24	1	-	1	12	9	3	30	42	125	58	1	-	1	-	-	28	26	13	33
25	-	-	4	7	17	9	29	55	126	59	4	-	7	-	1	31	41	20	60
26	4	-	1	9	52	17	17	86	108	32	4	1	12	3	1	12	43	27	78
27	2	-	3	3	65	22	5	92	51	19	5	-	21	6	3	5	40	32	67
28	8	-	3	5	65	26	-	91	33	9	5	-	12	1	-	5	13	10	47
29	4	-	3	5	43	17	-	60	30	10	7	-	8	1	1	3	11	6	39
30	2	-	2	1	39	16	-	55	46	11	9	-	4	1	6	2	6	3	54
31	2	-	2	2	28	12	-	40	66	8	7	-	3	1	10	1	5	2	74
32	1	-	1	4	46	14	-	60	57	7	7	-	2	-	8	5	11	4	86
33	1	-	2	3	56	26	-	82	44	6	3	-	4	-	3	6	5	2	77
34	-	-	1	3	47	26	-	73	48	4	2	-	3	1	2	5	2	2	77
35	1	-	2	1	47	13	-	60	21	1	1	-	4	1	1	5	-	-	48
36	-	-	2	-	27	12	-	39	12	1	-	-	1	1	3	3	-	-	10
37	1	-	1	-	11	5	-	16	8	1	2	-	1	-	1	3	1	-	13
38	-	-	1	-	2	2	-	4	10	-	-	-	-	-	1	3	-	-	8
39	-	-	-	-	1	-	-	1	6	2	1	-	-	-	-	3	1	-	11
40	-	-	1	1	3	-	-	3	4	1	-	-	1	-	-	-	-	-	5
41	-	-	-	3	-	-	-	-	2	-	-	-	-	-	-	1	-	-	4
42	-	-	-	2	1	1	-	2	-	-	1	-	-	-	1	1	-	-	1
43	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	1	-	-	1	-	-	-	-	1	-	-	1	-	-	-
49	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
51	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
52	-	-	-	-	1	-	-	1	-	-	1	-	1	-	-	-	-	-	-
53	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
	802	314	596	162	563	221	465	1249	885	306	62	756	95	21	42	199	248	138	807

## XXIII.—WHITING.

## ABERDEEN BAY.

- Col. I. 31st October 1903.  
 „ II. 29th December 1903.  
 „ III. 11th February 1905.  
 „ IV. 29th March 1905.  
 „ V. 13th May 1902 (Doghole).

## BURGHHEAD BAY.

- Col. I. 20th October 1903.  
 „ II. 14th November 1903.  
 „ III. 28th December 1903.  
 „ IV. 23rd January  
 „ V. 29th December 1903.

## SMITH BANK.

- Col. I. 1st April 1904.  
 „ II. 23rd October 1903.  
 „ III. 12th December 1904.  
 „ IV. 27th December 1903.

## DORNOCH FIRTH.

- Col. I. 22nd October 1903.  
 „ II. 11th November 1903.  
 „ III. 7th December 1904.  
 „ IV. 27th December 1903.  
 „ V. 28th December 1903.  
 „ VI. 9th February 1905.

OFF FINDHORN.—1st April 1904.

Cm.	ABERDEEN BAY.					BURGHHEAD BAY.					SMITH BANK.				DORNOCH FIRTH.						Off Findhorn.
	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	V.	I.	II.	III.	IV.	I.	II.	III.	IV.	V.	VI.	
5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	-
6	9	-	-	-	-	-	-	-	-	-	-	-	-	-	5	7	3	1	-	19	-
7	9	-	1	-	-	2	-	5	1	-	-	-	1	-	7	-	-	-	-	-	-
8	3	-	-	-	-	4	4	15	4	-	-	2	-	-	16	21	5	1	51	1	-
9	5	-	1	-	-	11	11	29	8	-	-	2	-	-	24	25	15	1	106	7	-
10	16	-	1	-	-	11	18	21	11	-	-	-	-	-	46	39	15	17	179	25	-
11	60	5	15	2	-	10	32	50	12	3	1	41	1	3	52	82	31	43	254	49	-
12	67	34	28	13	1	3	43	67	18	4	2	71	8	12	47	95	69	90	310	119	-
13	106	133	39	96	10	4	49	82	15	6	2	47	20	27	19	52	133	107	177	192	-
14	88	163	28	144	7	2	20	56	16	7	-	20	27	3	5	35	124	81	64	139	-
15	40	106	19	88	11	-	12	31	3	3	2	8	29	13	3	32	70	62	30	70	-
16	17	30	5	16	9	-	4	6	2	1	8	1	17	2	1	18	25	36	12	19	-
17	8	11	2	3	8	-	-	8	-	-	1	8	-	10	2	2	10	6	19	5	6
18	3	1	1	-	9	2	-	1	-	1	5	-	6	1	-	5	1	13	-	-	1
19	6	-	1	-	9	2	-	-	-	-	4	-	1	-	-	2	-	6	-	-	2
20	9	-	1	-	26	1	3	1	-	-	14	21	1	7	-	-	-	6	-	1	8
21	28	-	6	1	29	7	2	1	-	2	51	46	-	7	1	-	1	1	-	-	11
22	26	-	-	1	41	9	2	1	4	1	108	52	-	10	1	-	-	6	-	-	21
23	24	-	-	-	31	3	6	3	5	-	155	35	1	15	-	-	-	-	-	-	37
24	28	-	-	-	26	4	12	3	7	-	145	26	1	15	-	-	-	-	-	-	40
25	17	-	-	-	22	7	14	5	3	-	129	18	1	14	-	-	-	2	-	-	46
26	17	-	-	-	10	4	9	-	8	-	123	10	-	5	-	-	-	-	-	-	31
27	33	-	-	-	9	4	14	-	-	-	74	7	-	5	-	1	-	-	-	-	26
28	25	-	-	-	5	1	29	-	4	-	49	4	-	2	-	-	-	-	-	-	22
29	13	1	-	-	2	2	24	1	3	-	29	2	-	1	-	-	-	-	1	-	10
30	16	-	-	-	4	-	14	-	1	-	15	-	-	2	-	-	-	-	-	-	14
31	8	-	-	-	2	-	13	-	3	-	12	-	-	-	-	-	-	-	-	-	7
32	7	1	-	-	1	1	6	-	1	-	2	-	-	-	-	-	-	-	-	-	7
33	3	-	-	-	2	-	6	-	1	-	4	-	-	-	-	-	-	-	-	-	3
34	2	-	-	-	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	1
35	-	-	-	-	-	-	2	-	-	-	1	-	-	1	-	-	-	-	-	-	2
36	1	-	-	-	1	-	1	-	-	-	2	-	-	-	1	-	-	-	-	-	2
37	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
43	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	701	498	148	364	275	94	355	386	131	29	955	420	124	147	233	421	496	494	1209	628	293

## XXIV.—GURNARD.

## ABERDEEN BAY.

Col. I.	11th February 1905.
Col. II.	30th May 1901.
Col. III.	13th June 1901.
Col. IV.	5th July 1901.
Col. V.	30th July 1901.
Col. VI.	31st July 1901.
Col. VII.	1st September 1904.
Col. VIII.	4th September 1901.
Col. IX.	20th September 1900.
Col. X.	13th October 1900.
Col. XI.	8th October 1901.
Col. XII.	31st October 1904.
Col. XIII.	5th November 1901.
Col. XIV.	17th December 1900.

## DORNOCH FIRTH.

Col. I.	9th February 1905.
Col. II.	3rd June 1901.
Col. III.	8th June 1903.
Col. IV.	3rd July 1901.
Col. V.	5th August 1901.
Col. VI.	22nd October 1903.
Col. VII.	5th November 1900.
Col. VIII.	11th November 1901.
Col. IX.	VII. and VIII. combined.
Col. X.	7th December 1904.
Col. XI.	27th December 1903.

## SMITH BANK.

Col. I.	5th June 1901.
Col. II.	8th November 1901.
Col. III.	12th December 1904.

Cm.	ABERDEEN BAY.														DORNOCH FIRTH.													
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.		
3	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
4	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-		
5	-	-	-	-	-	-	9	-	1	2	1	-	-	-	-	-	-	-	-	-	-	1	1	2	-	-		
6	-	-	-	-	-	-	3	-	1	3	1	-	-	-	2	-	-	-	-	-	-	5	5	-	-	-		
7	1	-	-	-	-	-	1	-	-	3	1	-	-	-	2	-	-	-	-	-	5	8	13	-	2	-		
8	1	-	-	-	-	-	-	-	-	1	1	1	-	-	1	-	-	-	-	-	9	18	27	-	2	-		
9	-	-	-	1	-	-	-	-	3	-	-	12	-	-	-	-	-	-	-	-	4	17	21	-	1	-		
10	-	-	1	12	-	-	-	-	-	-	1	1	-	-	2	-	2	-	2	-	2	8	10	-	-	-		
11	-	-	1	49	-	1	-	-	1	1	-	2	-	-	-	-	-	1	-	-	-	5	5	-	2	-		
12	-	-	-	39	-	3	-	-	2	2	2	1	-	-	-	-	-	1	1	3	1	4	-	-	-	-		
13	-	-	-	8	-	2	-	-	11	3	3	4	-	-	-	-	6	-	-	11	1	-	1	-	-	-		
14	-	-	1	4	-	5	-	-	17	5	2	4	-	-	-	-	7	-	-	2	-	-	-	-	-	-		
15	-	-	4	10	-	1	-	-	17	4	4	5	-	-	-	1	4	-	-	3	-	2	2	-	-	-		
16	-	1	6	16	-	1	-	-	4	4	2	3	-	-	-	1	8	1	1	1	1	-	1	-	1	3		
17	-	2	9	24	-	6	-	-	4	-	1	2	-	-	-	1	8	3	-	4	1	1	2	-	-	4		
18	-	2	2	3	-	16	-	1	3	-	-	-	-	-	-	1	4	4	-	2	1	-	1	-	-	1		
19	-	2	4	4	-	5	-	-	9	1	-	-	-	-	-	3	6	1	-	2	2	-	2	-	-	3		
20	-	5	5	1	2	4	-	-	12	-	-	1	-	-	-	5	1	-	1	-	4	-	4	-	-	4		
21	-	6	2	-	3	1	-	1	9	-	4	2	1	-	-	10	2	2	-	-	3	1	4	-	-	5		
22	-	2	1	-	-	2	-	1	4	1	1	-	1	1	-	17	1	1	2	2	-	-	-	-	-	11		
23	-	2	1	1	1	2	-	-	3	-	-	1	2	-	-	21	1	4	-	-	-	-	-	-	-	29		
24	-	-	-	1	-	2	-	-	2	-	1	-	1	2	-	12	-	2	-	-	-	-	-	-	-	0		
25	-	-	-	-	1	-	-	-	1	-	-	-	1	3	-	17	-	2	1	-	-	-	-	-	-	0		
26	-	-	-	-	-	1	-	-	1	-	-	-	1	2	-	15	-	1	-	1	-	-	-	-	-	1		
27	-	-	-	-	1	-	-	-	2	-	1	-	1	4	-	11	-	3	1	-	1	-	1	-	-	1		
28	-	-	-	-	-	1	-	-	2	-	-	1	1	-	-	14	-	1	-	-	1	-	1	-	-	-		
29	-	-	-	-	-	-	-	-	1	-	-	-	3	-	-	7	-	2	1	-	1	-	1	-	-	-		
30	-	1	-	-	-	1	-	-	-	-	-	-	4	-	-	1	-	-	1	-	-	-	-	-	-	-		

XXIV.—GURNARD—continued.

Cm.	ABERDEEN BAY.														DORNOCH FIRTH.											SMITH BAY.	
	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	I.	II.
31	-	-	-	-	-	2	-	-	2	-	-	-	3	-	-	8	-	-	1	1	-	-	-	-	-	1	2
32	-	-	-	-	-	-	-	1	2	-	-	-	4	-	-	3	-	-	2	-	1	1	2	-	-	1	2
33	-	1	-	-	-	-	-	-	-	-	-	-	4	1	-	2	-	-	-	2	-	-	-	-	-	3	1
34	-	-	-	-	-	1	-	1	-	-	-	-	2	-	-	8	-	1	-	-	-	-	-	-	-	1	2
35	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-	10	-	-	-	1	-	-	-	-	-	-	1
36	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2	-	1	2	-	-	-	-	-	-	-	3
37	-	-	-	-	-	1	-	-	1	-	-	-	1	-	-	4	-	2	3	-	1	-	1	-	-	-	-
38	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	2	-	1	1	-	2	-	2	-	-	1	2
39	-	-	1	-	-	-	-	-	-	-	-	-	2	-	-	2	-	1	-	-	-	-	-	-	-	-	-
40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-
42	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
43	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
44	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	-	-	-	-
45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
	2	24	40	173	8	60	17	6	115	32	26	30	35	13	7	190	50	33	24	35	44	68	112	4	8	92	100

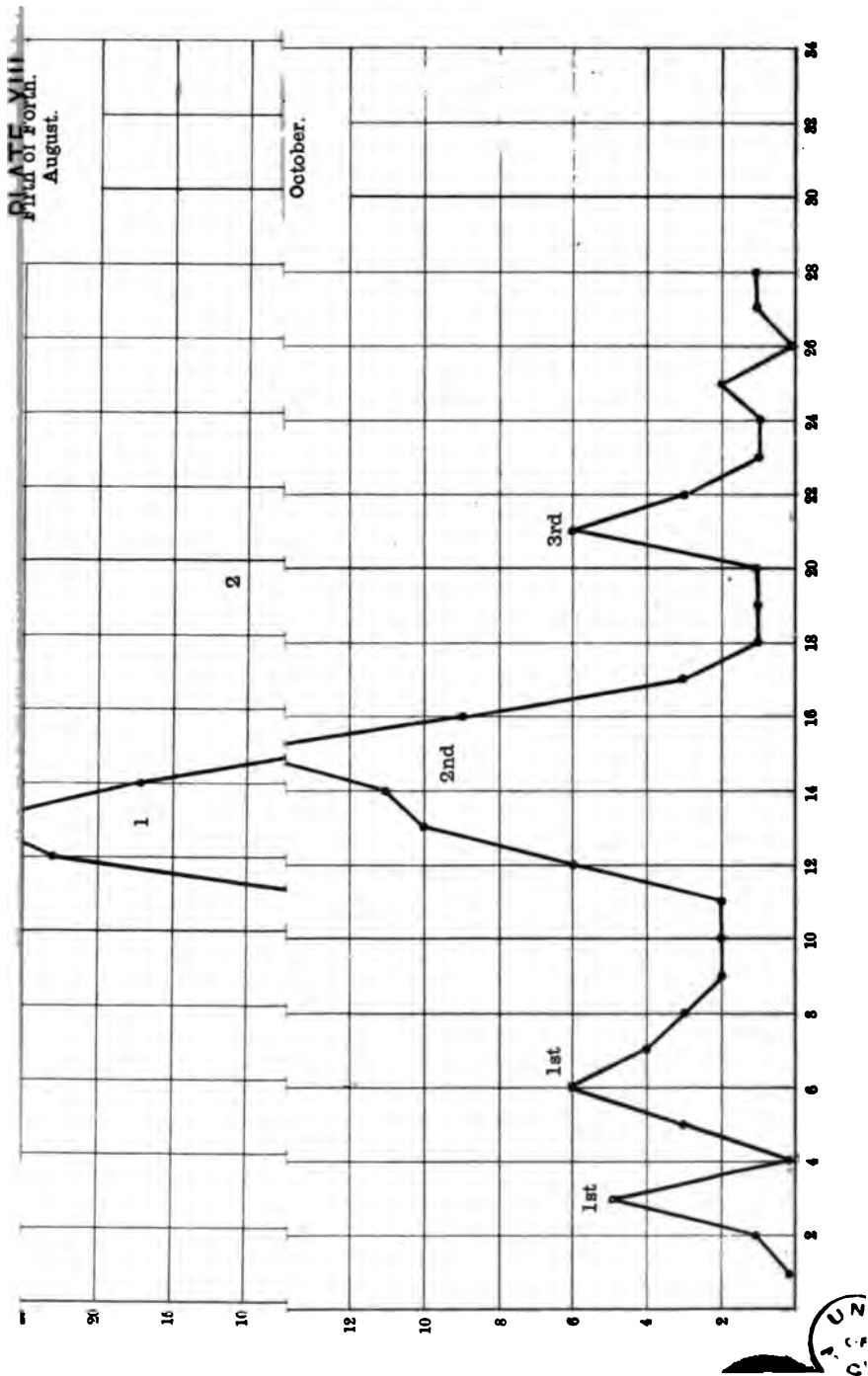


PLATE XII.

[illegible]

\_\_\_\_\_





\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

U

IX.—NOTES ON NEW AND RARE COPEPODA FROM THE  
SCOTTISH SEAS.

By THOMAS SCOTT, LL.D., F.L.S., Mem. Soc. Zool. de France.

(Plate XIV.)

PRELIMINARY NOTE.

The following are a few notes and drawings of rare Entomostraca that have been held over from previous papers on Scottish Crustacea, published from time to time in the Reports of the Fishery Board for Scotland.

I am indebted to my son, Mr. Andrew Scott, A.L.S., for the drawings with which these notes are illustrated.

Genus *Amphiascus*, G. O. Sars (1895).

*Amphiascus Catharinæ*, T. Scott, sp. n. Pl. xiv., figs. 1–9.

Description of the female:—Body robust, somewhat similar to *Amphiascus minutus* (Claus); Rostrum moderately elongated (fig. 1); length, .74mm. ( $\frac{1}{3}$  of an inch).

Anterior antennæ slender, reaching to about the end of the cephalo-thoracic segment, and composed of eight joints; the first, fourth, and last joints of moderate length, the others small, as shown by the formula (see also fig. 2).

Proportional length of the joints,	16	18	9	14	4	7	6	1
Numbers of the joints,	1	2	3	4	5	6	7	8

Posterior antennæ stout, two-jointed, and furnished with a moderately elongated and three-jointed outer ramus (fig. 3).

Mandibles tolerably stout, apex truncated and armed with several teeth of unequal length; palp well developed, basal part moderately stout and setiferous, and provided with two small branches, as shown in the drawing (fig. 4).

Second maxillipeds small, second joint moderately narrow and fringed with minute setæ; the end joint very small but armed with a tolerably large terminal claw (fig. 5).

First pair of thoracic legs slender, both branches triarticulate, inner branch with first joint narrow, considerably elongated, and apparently with only a few minute setæ near the proximal end of the inner margin and a small hair near its distal extremity; the two end joints very short and armed with a stout terminal claw and a tolerably large seta; there are also a few smaller setæ, as shown in the drawing. Outer branch about two-thirds the length of the first joint of the inner, the middle joint is rather longer than the first and fully twice as long as the third; these joints have the outer margin setiferous and are also furnished with long spines on the outer distal angles (fig. 6).

Both branches of the other three pairs are also three-jointed, elongated and slender, the inner branches being rather shorter than the outer, as shown in the drawing which represents the fourth pair (fig. 7).

Fifth pair tolerably large and foliaceous; basal joint somewhat triangular in outline, the distal half of the inner margin which slopes towards the apex is provided with three stout setæ, the inner margin is nearly straight and terminates in an angle, and immediately posterior to this angular tooth are two apical setæ, which are separated from the lowermost of the three on the inner margin by a *distinct hiatus*, as in the drawing. Secondary joint subquadrangular, its width being equal to nearly two-thirds of the length, the outer and inner margins are *nearly parallel at the proximal end*, but they taper from about the middle of the joint towards the apex and there are three setæ on the outer margin, one on the lower inner margin and two on the apex, as shown in the drawing (fig. 8).

Furcal joints very short (fig. 9). Principal tail setæ slender. Two ovisacs. Male unknown.

*Habitat*.—Granton, Firth of Forth; dredged in an old quarry to which the tide has access. Apparently rare.

*Remarks*.—In some respects *Amphiascus Catherinus* comes very near *Amphiascus (Dactylopus) minutus*, Claus., as described and figured by G. O. Sars,\* but the form and armature of the fifth pair of thoracic feet are totally different. Other but less obvious differences are also noticeable, as, for example, in the form and armature of the mandible-palp, the armature of the outer and inner branches of the fourth pair of thoracic legs and in the hirsute character of the first two abdominal segments. Unfortunately I have been unable to obtain the male of this form, but owing to the differences mentioned I prefer meantime to regard this as a distinct form from *A. minutus*.

Genus *Dactylopusia*, A. M. Norman (1903).

*Dactylopusia brevicornis* (Claus). Pl. xiv., figs. 10–18.

1866. *Dactylopus brevicornis*, Claus., Die Copepoden-fauna von Nizza, p. 29, Taf. iii., figs. 20–25.

1905. *Dactylopusia brevicornis*, G. O. Sars, Crust. of Norway, vol. v., p. 130, pl. lxxx.

The female of this species, like that of some others of the same group, has the cephalothorax depressed and broadly ovate, but the abdomen is comparatively narrow (fig. 10). Rostrum short, with a broadly rounded apex. Length .77mm. ( $\frac{1}{3}$  of an inch).

Anterior antennæ composed of five joints, very short and stout; the first three are more robust than the remaining two joints, the end joint is fully twice as long as the penultimate one (fig. 11). The formula shows the proportional lengths of the various joints as follows:—

Proportional lengths of the joints,	-	18	12	16	6	17
Numbers of the joints,	-	1	2	3	4	5

Posterior antennæ stout, two-jointed, with a short three-jointed outer ramus (fig. 12).

Mandibles stout, with an obliquely truncate apex, which is armed with a few large and several small teeth. Mandible palp with a dilated basal part bearing two very short uniarticulate branches (fig. 13).

\* Crustacea of Norway, vol. v., p. 154, pl. xvi. (March 1906).

Second maxillipeds short, stout, with a strong terminal claw (fig. 14).

The first pair of thoracic legs stout, both branches three-jointed; the first joint of the inner branch is as long as the entire outer branch, while the second and third joints are very short; a long plumose seta springs from near the middle of the inner margin of the first joint, but the outer margin is fringed with small spines, the inner branch bears two strong, but unequal, terminal claws; the first and second joints of the outer branch are subequal, and are each furnished with a stout elongated spine near the outer distal angle, the second joint being also provided with a long plumose seta on the inner margin, the end joint is tolerably short and is armed as shown in the drawing; a stout spine also springs from both the outer and inner angles of the second basal joint (fig. 15).

The next three pairs of thoracic legs have also both branches three-jointed, the inner being the shorter one; both branches have their outer margins fringed with spines. In the fourth pair (fig. 16.) the inner margin of the first joint of the inner branch carries one seta. The second two setae, and the end joint four setae. A short spine also springs from the outer distal angle of the third joint.

The fifth pair foliaceous, basal joint broadly triangular, with a truncated and broadly but irregularly rounded apex which bears five stout setae of various lengths. Secondary joint broadly subquadrangular, proximal half of the outer margin nearly parallel with the inner, but the distal half tapers towards the apex and carries three setae, other three setae spring from the apex and lower part of the inner margin (fig. 17).

Furcal joints very short; the inner of the two principal tail setae with the base slightly dilated (fig. 18).

*Habitat*.—Collected in an old quarry, open to the sea, at Granton, Firth of Forth.

*Remarks*.—The form described here under the name of *Dactylopusia brevicornis*, Claus, undoubtedly belongs to that species. The drawings, though only now published, were prepared a number of years ago from specimens collected in an old quarry at Granton, Firth of Forth, to which the tide has access.

The abbreviated length and massive structure of the antennules; the structure of the mandibles, the stout first pair of thoracic feet, and the form of the fifth pair are sufficiently characteristic of this particular species.

The following list of some of the rare and interesting species that have been obtained in the old quarry at Granton just referred to may be of interest, as indicating the remarkable variety of organisms present in this small body of water. The species are arranged alphabetically:—

- Acartia bifilosa*, Giesb.
- Ameira longicaudata*, T. Scott.
- Beatricella mimica*, T. Scott.
- Canthocamptus parvus*, T. Scott.
- Canuella perplexa*, T. and A. Scott.
- Cletodes similis*, T. Scott.
- Dactylopusia brevicornis*, (Claus).
- „ *finmarchicus*, (T. Scott).
- „ *vulgaris*, G. O. Sars.
- Ectinosoma curticorne*, Boeck.
- Enhydrosoma incurvatum* (B. & R.).
- Euryte longicauda*, Philippi.
- Halicyclops æquoreus* (Fischer).
- Harpacticus obscurus*, T. Scott.
- Idya furcata*, Baird.
- „ *gracilis*, T. Scott.

- Idya minor*, T. Scott.  
*Laophonte curticauda*, Boeck.  
     " *gracilis*, T. Scott.  
     " *hispida*, B. & R.  
     " *inopinata*, T. Scott.  
     " *intermedia*, T. Scott.  
     " *littorale*, T. and A. Scott.  
     " *longiremis*, T. Scott.  
     " *thoracica*, Boeck.  
*Longipedia Scotti*, G. O. Sars.  
*Nannopus palustris*, G. S. Brady.  
*Parathalestris hibernica* (Brady & Robertson)  
*Platychelipus littoralis*, G. S. Brady.  
*Pontopolites typicus*, T. Scott.  
\**Pseudothalestris major*, T. and A. Scott.  
*Stephos Scotti*, G. O. Sars.  
*Tuchidius dicipes*, Giesb.  
     " *littoralis*, Poppe.  
*Zaus spinatus*, Goodsir.

Genus *Pseudodiosaccus*, T. Scott (1906).

*Pseudodiosaccus propinquus* (T. and A. Scott). Pl. xiv., figs. 19–29.

1893. *Diosaccus propinquus*, T. and A. Scott. Ann. and Mag. Nat. Hist., ser. 6, vol. xii. (Oct., 1893), p. 237, pl. xi., figs. 1–6.

1906. *Pseudodiosaccus propinquus*, T. Scott. Ann. and Mag., May, 1906, p. 465.

This species was obtained in the Moray Firth, a few miles to the northward of Kinnaird Head, where the water is very deep; the particular part where this species was obtained gave a sounding of 130 fathoms (240 metres), the dredge line hanging free, and straight up and down. As the species appears to be rare, and as the number of drawings used to illustrate the description were only sufficient for its identification, I propose to supplement the original description with some additional remarks and drawings, especially as it has been considered necessary to remove the species from the genus to which it was first ascribed.

\* Professor G. O. Sars, in Vol. V. of his great work on the Crustacea of Norway, at present in course of publication, deals with what is probably the most difficult as well as the most interesting group of the Copepoda, viz.:—the Harpacticoida. In this volume, at p. 142, the learned author is inclined to regard *Pseudothalestris major*, T. and A. Scott, as identical with *Westwoodia minuta*, Claus. The description and figures of this form given by Dr. Claus are meagre—they are not only limited and indefinite, but it is only the male that he describes. On the other hand, Professor Sars' description and figures of what he believes to be the female of Claus' species are full and clear, like all that author's work, and they no doubt show a certain close resemblance to the female of *Pseudothalestris major*. But there is at least one point where an important difference occurs. The author describes the antennules of the female as composed of six joints, whereas those of the female of *Pseudothalestris major* are eight-jointed, the first four being moderately elongated and the other four shorter. There appears also to be some difference in the structure of the posterior antennæ.

It may also be noted that the same author makes *Pseudothalestris* Brady, a synonym of *Westwoodia*, Baird, but as the small group of species that have been arranged under the genus name *Pseudothalestris* are clearly distinguishable from *Westwoodia* by the difference in the structure of the first pair of thoracic feet, I prefer to keep them separate under the genus instituted by Dr. Brady. The fact that all the species belonging to the group hitherto arranged together under *Pseudothalestris* are similarly characterised by the peculiarity in the structure of the first pair of feet that distinguishes them from the typical *Westwoodia* is, I think, a valid reason for keeping them separate from that genus.

The female of this species, as already described, resembles to some extent that of *Diosaccus tenuicornis*, Claus, in its general appearance, but is probably somewhat larger. It measures about 1mm. (or  $\frac{1}{25}$  of an inch) in length, exclusive of the tail setæ (fig. 19).

The antennules (anterior antennæ) are moderately elongated, and composed of eight joints; the first four joints are moderately large, and are together considerably longer than the entire length of the last four. The fifth joint is little more than half the length of the preceding one and about two-thirds of the length of the sixth joint. The end joint is about equal in length to the fifth, but the penultimate one is considerably shorter, as shown in the drawing (fig. 20).

The outer and inner rami of the posterior antennæ are both of them biarticulate. The outer ramus, which has the joints subequal, is short, and furnished with about three short setæ. The inner ramus is moderately stout (fig. 21).

The mandibles are stout, and possess a broad and somewhat obliquely truncated biting edge, which is irregularly but distinctly dentated. Mandible palp of moderate size, and provided with a single terminal unarticulate branch (fig. 22).

The maxillæ are moderately stout and compact, and the masticatory lobe, which is short, and obliquely truncated, is armed with a number of tolerably strong spines of varying lengths; the palp is fairly well developed (fig. 23), and consists of several lobe-like processes as shown.

Second maxillipeds robust, and armed with a stout elongated terminal claw (fig. 24).

The first pair of thoracic legs have both branches three-jointed; the first joint of the inner branch is considerably elongated, but the second and third are very short and subequal, and the end one is armed with two terminal claw-like spines, one being moderately long and one short; a small seta also springs from near the distal end of the inner margin of the first joint. The outer branch is little more than half the length of the inner one; the first two joints are subequal, but the third is short, and furnished with several spiniform setæ, as shown in the drawing (fig. 25).

The second and third pairs, which have also both branches three-jointed, are moderately stout, and the outer and inner branches are of nearly equal length. In the second pair the first joint of the inner branch is rather shorter than the second, and it carries a single seta on the inner margin; the second joint carries three setæ, and the end joint one seta, on the inner margin; the end joint is also provided with three terminal setæ, but the outer one is short. The outer branch has the end joint rather longer than the preceding one, and furnished with two elongated setæ on the inner margin, two moderately long spines on the outer margin, and three apical setæ of different lengths; the first and second joints are each furnished with a moderately long spine on the outer distal angle, and an elongated seta on the inner margin (fig. 26).

In the fourth pair the outer branch resembles that of the second pair in stoutness and armature, but the inner branch is slender and short, and composed of only two joints; the first joint, which is narrow and shorter than the second, bears a seta on the inner margin; the second joint scarcely reaches beyond the end of the middle joint of the outer branch, and carries five setæ round its distal extremity (fig. 27).

In the fifth pair the outer and inner margins of the basal joint are nearly parallel; the distal end is obliquely truncated and slightly convex, and bears four moderately long marginal setæ, so arranged as to be nearly equidistant from each other. The secondary joint is broadly oval in outline, and extends considerably beyond the end of the basal joint; it

is provided with six setæ, which are arranged as follows:—One small seta on the upper half and another on the lower half of the outer margin and situated considerably apart, and four setæ round the distal extremity; the outermost and innermost seta is moderately large and plumose, but the two intermediate ones are small and close together (fig. 28)

Furcal joints as long as the last abdominal segment (fig. 29). Ovisacs two. Only three specimens—all females—were obtained.

Remarks.—This species, as already stated, has some resemblance to *Diosaccus tenuicornis*, Claus, but the structure and armature of the mandibles, maxillæ, and fourth pair of thoracic legs are so distinctly different that though the species was at first ascribed to that genus it cannot be retained there, and a new genus, *Pseudodiosaccus*, has therefore been instituted for its reception, as indicated above. This genus appears to partake of the characters of both *Diosaccus* and *Amphiascus*, but in the structure of the fourth pair of thoracic legs it agrees with neither of these two genera.

It resembles *Diosaccus* in the structure of the posterior antennæ, of the mandible palp, and to some extent in the structure of the first and fifth pairs of thoracic legs; while in the maxillæ, second maxillipeds, and the second and third pairs of legs it resembles *Amphiascus*.

## PLATE XIV.

*Amphiascus Catharinæ*, T. Scott.

- Fig. 1. Female, side view.
- Fig. 2. Antennule.
- Fig. 3. Antenna.
- Fig. 4. Mandible.
- Fig. 5. Posterior foot jaw.
- Fig. 6. Foot of first pair.
- Fig. 7. Foot of fourth pair.
- Fig. 8. Foot of fifth pair.
- Fig. 9. Abdomen and furcal joints.

*Dactylopusia brevicornis*, Claus.

- Fig. 10. Female, dorsal view.
- Fig. 11. Antennule.
- Fig. 12. Antenna.
- Fig. 13. Mandible.
- Fig. 14. Posterior foot-jaw.
- Fig. 15. Foot of first pair.
- Fig. 16. Foot of fourth pair.
- Fig. 17. Foot of fifth pair.
- Fig. 18. Abdomen and furcal joints.

*Pseudodiosaccus propinquus*, T. Scott.

- Fig. 19. Female, side view.
- Fig. 20. Antennule.
- Fig. 21. Antenna.
- Fig. 22. Mandible.
- Fig. 23. Maxilla.
- Fig. 24. Posterior foot-jaw.
- Fig. 25. Foot of first pair.
- Fig. 26. Foot of second pair.
- Fig. 27. Foot of fourth pair.
- Fig. 28. Foot of fifth pair.
- Fig. 29. Abdomen and caudal furca.







X. —ON THE SPAWNING AND FECUNDITY OF THE PLAICE  
(*PLEURONECTES PLATESSA*). By T. WEMYSS FULTON,  
M.D., F.R.S.E., Superintendent of Scientific Investigations.

The spawning period of the plaice has been very well determined for various parts of the North Sea. On the east coast of Scotland it extends from the end of December in some years, but more usually from the early part or middle of January, to the early part or middle of May, the chief spawning taking place in March.

The records of the Marine Hatchery at Aberdeen furnish some details of interest as to the length of the spawning season and the intensity of spawning in the various months. Thus last year eggs were obtained from the spawning pond for 117 days, from 20th January till 16th May. The number of eggs obtained in the various months during the last three years, and the percentages of the total, are as follows :—

	Number of Eggs.	Percentage.
January, . .	1,980,000	1·5
February, . .	31,402,000	22·3
March, . . .	78,595,000	53·5
April, . . .	31,911,000	21·3
May, . . . .	1,762,000	1·2

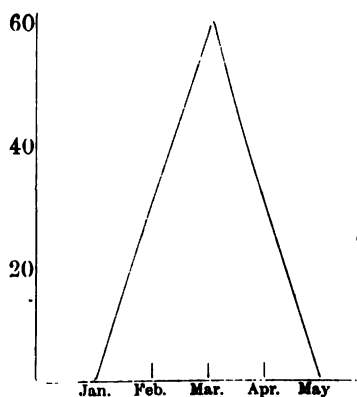


Fig. 1.

The curve (Fig. 1) formed by these figures is very regular, and, as will be seen, the spawning is at its height about the middle of March.

It has not yet been shown, however, over what part of the period a single female continues to discharge her eggs. It is well known that most or all fishes producing isolated pelagic eggs do not get rid of them at once. They are spawned in relatively small quantities at a time and over a longer or shorter period. As I have elsewhere shown,\* this is a physical necessity, since a female cannot hold all the eggs at the size they possess when mature, and they must ripen gradually and in succession.

It was in order to determine the duration of the spawning in a single female, and some other points in connection with spawning, that the following experiments were chiefly made. But another object I had in view was to ascertain the number of eggs actually shed into the water, *i.e.*, the real fecundity. This has been approximately determined for the

\* "The Comparative Fecundity of Sea Fishes," *Ninth Annual Report*, Part III., p. 242; "On the Growth and Maturation of the Ovarian Eggs of Teleostean Fishes," *Sixteenth, Ibid.*, p. 88.

plaice already in one of the papers above alluded to, but by a different method, viz., by counting the eggs in a given portion of the ovary after the death of the fish, and then computing the total numbers.

The experiment consisted in keeping two female plaice, which were nearly ready to spawn, in separate tanks, with one or more mature males with each of them, until spawning was quite concluded; to collect all the eggs daily and ascertain their numbers.

The tanks in which the experiments were made are similar in all respects. Each is 6 feet 4 inches in length, 4 feet 3 inches in breadth, and 3 feet 6 inches high, and the water was kept at a level of 28 inches throughout the period. The quantity of water was thus about 62 cubic feet, or 385 gallons (1749 litres). The flow through it amounted to about 80 gallons per hour. The glass front of the tank was covered over with an old sail, and light was admitted from the top, but it was not very strong. The water entering the tanks was filtered through close and thick flannel to obviate the chance of eggs getting into them in that way; and no other fish or organisms were in the tanks—nothing but the plaice.

The overflow from each tank was carried into two boxes, each about a foot square, the bottoms of which were covered with fine silk-netting, so that all eggs might be retained; these were partly immersed in order to keep the eggs living, and the water passed from one of the boxes into the other, being thus twice filtered, an arrangement adopted lest the fine apertures in the silk gauze in the first box should get clogged up during the night.

The method of dealing with the eggs was as follows:—Each collection, daily, or, usually, twice a day, was preserved in sea-water with a little formaline. The eggs were then strained off and spread on blotting paper, and as much of the water and moisture as possible removed. They were then added to a long burette, graduated to tenths of a cubic centimetre, in which a certain measured quantity of water had been placed. The difference between the readings before and after the eggs were introduced gave the volume of the eggs in cubic centimetres. Some were also weighed on a Sartorius balance. A portion of the eggs in each collection were treated in a similar way and, after the volume had been determined, were counted. The number of eggs per cubic centimetre, and the total quantity of eggs in the collection, were thus estimated.

Two suitable female plaice were selected from those in the spawning pond (used in connection with the hatchery), *i.e.*, which had swollen ovaries and obviously would soon spawn, but which contained no ripe eggs. This was ascertained by pressure in the ordinary way. On the other hand, males were taken from which spermatoc fluid was already oozing, in order to provide that the eggs should be fertilised, and to furnish such psychological stimulus to the female as might be necessary and natural.

On the 19th February the following plaice were put into the tanks:—In No. 5 a female measuring 47cm. ( $18\frac{1}{2}$  inches) and weighing 1324 grammes (2 lbs.  $14\frac{3}{4}$  ounces), and a male of 43cm. (17 inches) and weighing 842 grammes (1 lb.  $13\frac{3}{4}$  ounces). In tank No. 2 the female measured 46.5cm. ( $18\frac{1}{2}$  inches) and weighed 1536 grammes (3 lbs.  $6\frac{1}{4}$  ounces), and was thus heavier than the other. Two males were put in with her, measuring respectively 38.6cm. and 40cm.

In the course of the experiment, when a pause occurred in spawning, the males were sometimes replaced by fresh ones taken from the pond, as mentioned later.

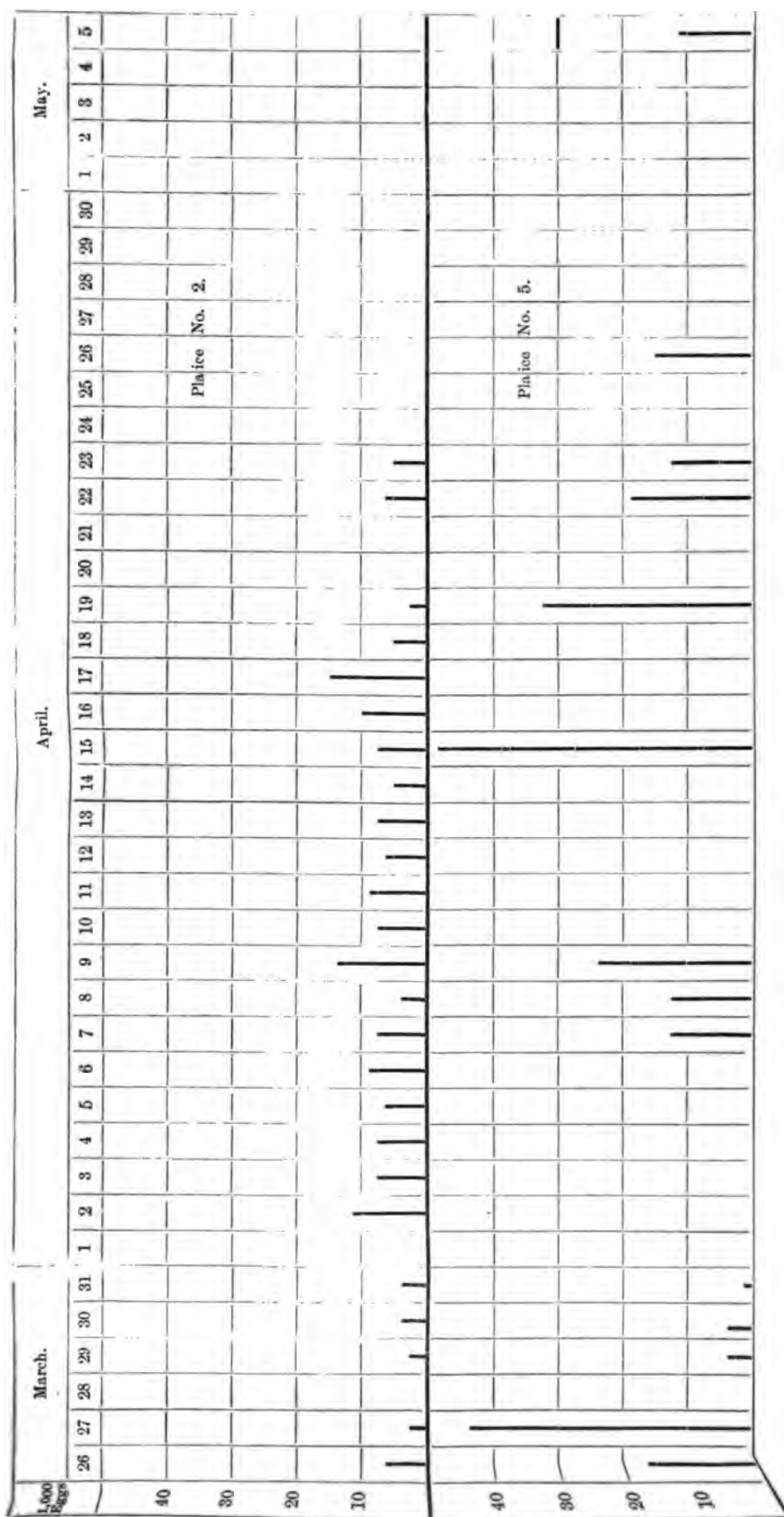
No eggs were obtained from either tank until 19th March. During the interval the males and females lay quiet in a corner of the tank. In No. 5, for example, the female lay with her snout as far as possible into the

corner, the male snuggling up close beside her, between her and the wall. They were never observed swimming about, and only rarely shifted their position. They did not take any food; the mussels thrown in one day were removed on the following day. The male in No. 2 was curiously coloured. Along the sides, near the base of the fins, there were six equidistant and subequal spots of chalky white, from  $\frac{1}{2}$ – $\frac{3}{4}$  inch in diameter; there was a similar spot at the root of the tail and another near the base of the pectoral fin. Between these were single dullish-red spots, by no means conspicuous; white rings were not observed around them. Similar red spots were scattered over the surface. The female was dull-coloured and her spotting not very noticeable.

The particulars as to the spawning of each female from day to day are given in the following Table, and also in the diagram on the opposite page, the numbers in the first column representing 1000's of eggs.

[TABLE.

Time of Collection.		Eggs Collected.		Quantity taken for Computation.				Number per C.C.		Estimated Total Number.		Temperature of Water.	
		C.C.		C.C.		Number.							
Day.	Hour.	2	5	2	5	2	5	2	5	2	5	2	5
Mar. 19		18		18		3003		166.9		3,003			
" 20													
" 21													
" 22													
" 23													
" 24													
" 25													
" 26		28.98	62.8	1.08	4.3	237	1085	219.4	252.3	6,359	15,846		
" 27	7.10a	8.5	22.5	8.5	22.5	1796	5542	211.3	243.6	1,796	5,542		
" 27	2.20	7.1	158.7	7.1	8.8	1316	2155	185.35	244.8	1,316	38,863		
" 28													
" 29	2.30p	11.09	10	2.38	10	542	2608	227.7	260.8	2,525	2,608		
" 30	3.30p	16.15	9.2	1.45	2.2	324	611	223.4	277.7	3,609	2,555		
" 31	1.15p	15.58		1.2		274	155	228.3		3,557	155		
April 1													
" 2	10a	49.0		2.15		490	88	227.9		11,167	88		
" 3	2.30p	28.9		1.6		385		240.6		6,954			
" 4	3p	28.87		1.77		422		238.4		6,883			
" 5	3p	24.8		1.2		285		237.5		5,890			
" 6	3p	38.45		1.65		381		230.9		8,878			
" 7	9.30a	30.45	45.5	1.45	2.4	335	626	231.8	260.8	7,035	11,868		
" 8	10a	10.86	39.4	0.66	1.5	185	458	280.3	305.3	3,044	12,030		
" 9	7.30a	50.35	92.15	3.15	3.1	808	804	256.5	259.4	12,015	23,899		
" 9	4.50p	3.8		0.99		236		238.4		906			
" 10	7.10a	24.89		1.69		427		252.7		6,288			
" 10	4.45p	3.5		3.5		702		200.6		702			
" 11	7.15a	22.9		1.0		255		255		5,840		45.4	44.8
" 11	4.45p	6.95		0.75		199		265.3		1,844			
" 11	7.15a	21.56		1.21		316		261.1		5,629		45.4	45.1
" 12	11a												
" 12	4.45p												
" 13	7.10a	22.85		4.75		1231		259.2		5,922		46.8	46.4
" 13	4.45p	3.91		1.21		280		231.4		905			
" 14	7.10a	15.98		1.63		482		265.0		4,235		46.2	45.7
" 14	3.20p	2.77		2.77		766		276.5		766			
" 15	2p	24.3	134.75	1.7	3.25	489	1186	287.6	364.9	6,989	49,170	47.1	46.1
" 16	7.10p	38.1		2.0		507		253.5		9,658		48	46.2
" 16	4.45p												
" 17	7.10a	53.35		2.1		586		279		14,887			
" 17	4.45p	.90		.90		308		342		308		44.2	44.2
" 18	7.10a	15.35		1.55		503		324.5		4,981		45.3	45.0
" 18	4.45p												
" 19	7.10a	9.7	104.85	.75	6.85	159	2155	212	314.6	2,056	32,828	40.8	41.2
" 19	4.45p												
" 20	7.15a											42.3	42.1
" 20	4.30p												
" 21	7.10a											45.7	45.3
" 22	9.15a	23.6	54.2	2.0	2.7	462	941	231	348.5	5,452	18,888	45.0	45.0
" 23	7.15a	10.8	38.0	1.1	2.1	434	660	394.5	314.3	4,261	11,943	42.8	42.8
" 23	4.45p												
" 24	7.15a											40.6	41.0
" 24	7.10a											40.6	41.2
" 25	4.45p												
" 26	7.15a		50.44		3.34		1022		306		15,587	42.3	42.4
" 26	4.45p												
" 27	7.15a											43.9	43.5
" 27	4.45p												
" 28	7.30a											44.2	43.9
" 29												44.6	44.2
" 30	7.20a											45.5	45.0
" 30	4.45p												
May 1	7a											44.6	44.6
" 2	7.15a											44.4	44.8
" 3	7.15a											46.8	46.0
" 4	7.10a											47.8	47.1
" 5	12p		3.4		4.0		1272		318		10,907	46.9	46.8



The quantity of eggs obtained from No. 2 on 19th March was small, and there was a pause until the 26th, when the spawning began in reality. In the case of this fish the emission of eggs went on very steadily until the 19th April, eggs being got daily. From 19th to 22nd April spawning was interrupted, and the last eggs were obtained on 23rd April. The spawning of this female thus extended over a period of 36 days from first to last, but was chiefly limited to the interval from 26th March to 23rd April, or 28 days; only on three days in that time were no eggs found to have been spawned.

The characters of the spawning of this fish were a regular, small or moderate, quantity of eggs on each day. The average number emitted per day for the 25 days that they were emitted was 6542; the largest on any one day was 15,195 on 17th April, the next largest being 13,832 on 17th April; the smallest was 2056 on 19th April, and 2525 on 29th March.

The other female, in tank 5, offered a striking contrast to the above. Its spawning extended over a period of 41 days, viz., from 26th March to 5th May; but eggs were spawned on only 16 days during that time. There were thus long intervals without any eggs being obtained; as much as nine days. As the Table shows, it spawned most regularly at first, each day from 26th March to 2nd April (no collection was taken on the 28th or 1st). It will be noticed that the quantity of spawn emitted on the second day was very large, and it then diminished, only 155 eggs being found on the 31st March, and only 88 on 2nd April. The ovaries were greatly distended when spawning began, and the figures show that the fully mature eggs which had collected were got rid of in about five days, after which a rest for some days occurred.

This female spawned again on the 7th April, and for the next two days; then not again until the 15th; then on the 19th, 22nd, and 23rd; then on the 26th, and finally on 5th May. The seven "bursts" of spawning were as follows:—

	Dates.	Number of Eggs Spawned.	Ratio per 1 C.C.
1	26th March-2nd April, . . .	65,657	255·64
2	7th-9th April, . . . . .	47,797	272·2
3	15th April, . . . . .	49,170	364·9
4	19th April, . . . . .	32,828	314·6
5	22nd, 23d April, . . . . .	30,831	331·4
6	26th April, . . . . .	15,587	306·0
7	5th May, . . . . .	10,907	318·0

The largest numbers on any one day was 49,170 on 15th April, and 44,405 on 27th March; the smallest daily amount was 88 and 155, which might almost be considered accidental, the next being 2555. The average per day for the 15 days on which spawning occurred was 16,852 eggs.

The aggregate quantity of spawn from No. 2 over the whole period was 654·29 cubic centimetres, and the estimated number of eggs was 163,557.

The aggregate from No. 5 was 856·79 cubic centimetres, and the estimated number of eggs was 252,777.

[TABLE.]



The quantity and numbers for each month were:—

	No. 2.		No. 5.	
	C.C.	No.	C.C.	No.
March, .	71·82	15,605	263·2	65,414
April, .	582·47	147,952	559·29	176,456
May, .	—	—	34·30	10,907

The quantities taken for enumeration were 84·94 cubic centimetres for No. 2 and 77·04 for No. 5, or about 13 and 9 per cent. of the totals; and the numbers of eggs counted were 19,075 of No. 2 and 21,400 of No. 5, the total being 161·98 cubic centimetres, and 40,475 eggs.

With regard to the fecundity of the fishes, these results agree very well with those deduced previously from weighing part of the ovary and enumerating the eggs. Thus, in the paper referred to in the *Ninth Annual Report*, I describe a female of 17½ inches, and weighing 2 lbs. 10 ounces, with an estimated number of 148,470 eggs, and another of the same size and weighing 3 lbs. 0¼ ounces, with 223,497; the average for the five plaice there dealt with being 19·9 inches in length, 3 lbs. 10¼ ounces (1664 grammes) in weight, and 301,394 eggs.

Before referring further to the facts brought out in the Table, I may describe some of the occurrences in regard to the fishes and their treatment.

On 31st March a fresh male quite ripe was put into tank No. 5. The female was observed to be lying apart from the males, all of which had conspicuous red spots, but not nearly so bright as one often sees on plaice brought to deck at the fishing grounds at other times of the year. The ovaries were sometimes enormously swollen, so much so that I was afraid that the “egg-bound” condition was about to supervene. It appears, however, to be natural, and a certain distension occurred before the eggs were allowed to run from the oviduct. After a “burst” of spawning they were notably reduced in size.

On the 6th April, a fresh ripe male was put with No. 5, and the spawning, which had been interrupted, began on the same night. On the occasions when No. 5 stopped spawning, she was usually observed to be lying away from the males. The latter, it may be remarked, appeared to have no contests for the privilege of fertilising the eggs, as with the lumpsuckers in an adjoining tank. They were always lying quietly, and often, or even usually, together.

The ovaries of No. 2 were, as a rule, more swollen than those of the other female.

On 13th April two ripe males were put into No. 5, and she spawned again on the 15th.

With regard to food, mussels were only occasionally eaten, probably by the males; only on one occasion was any slimy matter which might have come from the intestines observed in the overflow, and in pressing the plaice taken from the tank to select those for the experiment, no excrements were pressed out.

After No. 5 stopped spawning on the 26th, she was observed to be adhering to the vertical side of the tank, a position she occupied for a day or two, as if desiring to be freed from the attention of the males.

Spawning was never actually observed, but the Table shows that it takes place usually at night, though it does not always do so (see 27th

March). As a rule, however, very much less spawn was collected in the afternoon than in the morning, and part may have been derived from the spawning during the night.

The difference between the two females was not confined to the spawning. There was a noteworthy difference in the eggs, not merely as to quantity but as to size. After some experience in the enumeration, it was possible to tell whether a collection was from No. 2 or No. 5, owing to this difference. Those from No. 5 were smaller.

Thus the mean number per cubic centimetre of the eggs from No. 2 was 250 (249·98), while the mean number from No. 5 was 245 per cubic centimetre, a difference of 45 per cubic centimetre. In other words, the eggs of one plaice were about 18 per cent. smaller than those of the other. With one exception (23rd April) the number per cubic centimetre was always greater in the second plaice, No. 5, that is to say, its eggs were smaller.

The ratio of number of eggs to 1 cubic centimetre in No. 2 was 185·35 at the beginning of spawning, and 394·5 at the close; in No. 5 it was 243·6 at the beginning, and over 300 later, the highest being 364·9 on 15th April.

This difference was partly due to the fact that in No. 2 there was in almost every collection a proportion of the eggs much larger than others; in some of the collections this was very noticeable. They graduated from very large ones, swollen, and, it might be said, hydropic, to small ones; the range of size being considerable from the smallest to the largest.

The eggs spawned by the other female (No. 5) were much more uniform in size. Whether differences of this kind occur under natural conditions I do not know, but such large hydropic eggs of the plaice are sometimes taken from the spawning pond, and on one or two occasions led to the suspicion that they might belong to some other species. They appear to be produced by an excessive imbibition of the watery saline solution that enters the egg at the last stage of maturation.\* Whether they are fertilised and behave like the normal egg was not determined. Now and again a single egg was got stained bright yellow, no doubt from the bile; and several were blue, for what reason I did not discover.

It may be seen from the Table, moreover, that as spawning proceeded the size of the eggs tended to become smaller.

The fact may be seen from the averages for No. 5 given in the Table printed above; and, taking the mean of the first five averages (number per cubic centimetres) and the mean of the last five averages, we have the following:—

	No. 2.		No. 5.
26th–30th March,	213·43	26th–30th March,	255·84
17th–23rd April,	297·17	19th April–5th May,	320·28

The increase in the number with the first female was thus 83·74 per cubic centimetre, and in the second, 65·04 per cubic centimetre, the reduction in size amounting to 39·2 and 25·4 per cent. respectively.

The fact is of some interest, and is in all probability due to the comparative exhaustion of the water-secreting function of the ovary, water being, so far as volume is concerned, the chief product of that organ. It might, however, be owing to the eggs spawned later containing less yolk; a less probable explanation, for several reasons.

I may add that the mean of a number of fertilised plaice eggs taken from the large spawning pond at the same time was 307 per cubic centimetre, two samples varying from 312·27 to 301·63.

\* *Vide Sixteenth Annual Report, Part III., p. 89.*

I have elsewhere shown\* that at the last stages of the maturation of plaice eggs in the ovary the absorption of water by the eggs is enormous, amounting to at least two-thirds of the volume of the contents. Thus, in the 654 cubic centimetres of eggs produced by the female, No. 2, at least 536 cubic centimetres is represented by water absorbed not long before the eggs are extruded, and which is secreted by the fish. So in the other case; about 572 cubic centimetres of the 857 cubic centimetres of eggs represents water absorbed.

Both the plaice were kept in the tanks after the conclusion of spawning. On 9th May, no further eggs having come from the plaice in No. 2 since the 23rd of April, and spawning being clearly over, she was killed and examined. The length was the same, 46·5cm., and the weight was 2lbs. 8½oz. (1139·8 grammes), showing a loss of 14oz., or 396 grammes.

At the same time, the other plaice (No. 5) was also weighed. It was 2lbs. 6½oz. (1083 grammes), showing a loss of 8½oz., or 234 grammes. The measurement was a little less, viz., 46·7cm.

This fish was put back with the males into the tank, but no further spawning occurred. On 13th May she weighed 1119 grammes, and was still 46·7cm.; on 21st May the weight and length were the same, so that recovery was slow.

The loss in weight above referred to does not represent anything like the weight of the eggs spawned. Among those of No. 2 it was found that 56 cubic centimetres weighed 53 grammes, so that the total weight of the 654 cubic centimetres spawned would be about 619 grammes, or 223 grammes more than the loss of weight of the fish.

In the other plaice (No. 5) 6·7 cubic centimetres of eggs weighed 6·65 grammes, and the total weight of the whole quantity of 857 cubic centimetres would be about 850 grammes, or 616 grammes in excess of the loss of weight of the fish.

The difference is accounted for by the water secreted and absorbed as the eggs mature; also, no doubt, by the absorption of water by the muscles and tissues of the fish after spawning, the increase of weight in No. 5 after the 9th May being probably due to this, since no food was eaten.

When the first plaice (No. 2) was killed, on 9th May, the ovaries were found to contain a large quantity of spawn. When put into sea-water all went to the bottom within a few minutes, and the disc was chalky white, and in many cases wrinkled and irregular. They represent the eggs which the fish is unable to get rid of at the end of spawning, and which disintegrate and are absorbed. The quantity amounted to 43·95 cubic centimetres, of which 3·75 cubic centimetres contained 1482 eggs, or 395·2 per cubic centimetre. The estimated number of eggs thus retained in the ovaries and destroyed was 17,369, or over 10 per cent. of the number spawned, which indicates a very considerable loss.

The ovaries of the other plaice were in the same condition, slightly swollen, tumid, and soft.

\* *Ibid.*, p. 14. See also p. 145.

XL—ON TWO CASES OF HERMAPHRODITISM IN THE COD  
(*GADUS CALLARIAS*).

By H. CHARLES WILLIAMSON, M.A., D.Sc., Marine Laboratory,  
Aberdeen.

(Plates XV., XVI.)

Several cases of Hermaphroditism were noticed among the cod landed in Aberdeen during March, 1906. Two of these were secured from local fish-curing yards for the Marine laboratory. A third was reported to the Fishery Board from Whitehills; and a fourth is known to have been observed in Aberdeen.

The specimens here described were examined after having been two months in formaline solution; they exhibit two different arrangements of the ovaries and testes. In one case, fig. 1, pl. xv. and xvi., a fully developed female reproductive organ bears at the anterior extremity of each ovary a small testis, forming a symmetrical hermaphrodite organ. The other example (fig. 2, pl. xv. and fig. 4, pl. xvi.) shows a single roe of large size united to a full-sized testis. The organ on the right side is female, that on the left is male.

The symmetrical roe weighed about  $5\frac{1}{2}$  lb. It contained transparent eggs, showing that the roe was nearly ripe. The testis contained some ripe sperms, but there were none in the *vas deferens*. The testis, though well developed, was considerably short of being ripe. The main blood-vessel, *b.v.*, of the ovary reaches that organ at its anterior extremity. It is continued over the dorsum of the ovary along the base of the mesentery (after giving off a large branch to pass down on the inner surface of the ovary) to unite at the junction of the two ovaries with the corresponding vessel of the opposite organ. Before it reaches the ovary this large vessel gives off two branches  $b^1.v^1.$  and  $b^2.v^2.$ , one to each end of the loop-formed testis (fig. 2, pl. xvi.). Between the branch blood-vessels and the frill of the testis lies the *vas deferens*. This duct is closed at one end of the testis loop, viz., at *VD*, and it opens by its other extremity, *V'D'*, into the ovary, by three small openings. These openings were not so guarded as to prevent the eggs from getting out into the *vas deferens*, but the eggs found there were small yoked eggs, and they may have been forced out by the handling to which the roe was subjected. A fully ripe egg would probably not pass through the apertures. The general form of the testis is that of a loop; it is shown diagrammatically in fig. 3. The great development of the testis-frill on so short an extent of *vas deferens* has formed it into a compact mass, wherein the *vas deferens* is not to be seen until the folds are forced apart. The large blood-vessel of the ovary is accompanied by a thick walled vessel (*v.*) having a very small lumen.

The asymmetrical organ weighed  $3\frac{3}{4}$  lb. The ovary contained transparent eggs. Some ripe sperms were present in the testis; but there were none in the *vas deferens*. In this case a normal ovary is accompanied by a normal testis (fig. 4). The two unite in the anal region just as two ovaries or two testes do, and their ripe products escape by the

one genital aperture (*g.ap.*). In the cod each ovary or testis is supported to the roof of the abdominal cavity by a mesentery, which is attached longitudinally to the swim-bladder. The stomach and gut are similarly supported by a mesentery that hangs between the genital mesenteries. All three mesenteries are together connected to the union of the two ovaries (or testes). The rectum is supported by mesentery to the inferior part of the united ovaries. The two ovarian mesenteries are continued posteriorly as a single mesentery joined superiorly to the roof of the abdominal cavity, and extending to the hind extremity of the post-abdomen, where it unites with the peritoneum. The hind lobes of the ovary are attached, one on each side, to the mesentery. This mesentery also includes the ureter and urinary bladder, and binds them to the floor of the post-abdomen. The post-abdomen is thus divided longitudinally into two quite separate compartments.

This arrangement was found to hold exactly in the case of the second hermaphrodite specimen. The mesenteries were arranged quite normally. Since they are similarly arranged in both sexes, the substitution of one half of the ovary by a testis did not involve any abnormal arrangement of the mesenteries.

When the wall of the ovary near the genital aperture was dissected off it was seen (fig. 5) that the *vas deferens* from the hind part of the testis, viz., *V<sup>1</sup>.D<sup>1</sup>*, and that from the main testis, *V.D.*, opened into a common chamber, marked *sm.* in the drawing. The wall of this chamber is smooth; it is open below to the eggs in the ovary. Alongside the base of the ventrally descending portion of the testis the tissue is deeply honeycombed, and divided up with a network of stout fibres (*h.c.*). The passage of the sperms to the exterior appears to be as follows:—They pass from the upper smooth part to the honeycombed region, which probably acts as a sort of seminal receptacle, and from thence pass out along the smooth lower wall to the genital opening (*g.ap.*). The wall of the ovary near the genital aperture is smooth on the inside, whereas all the remaining wall bears the ovarian folds. The smooth part forms a gathering place for the ripe eggs, where they may collect away from the developing eggs, and when they may lie ready to be expelled. The smooth part of the skin of the ovary is shown in fig. 1, *sm.* In fig. 5, which shows the dissection of the hermaphrodite roe, the deflected sides are shown to be on one side partly smooth and in part covered with ovarian folds (*ov.f.*), and on the anterior side smooth (*sm.*). The smooth parts are the oviducal part.

It is clear that in the asymmetrical hermaphrodite both male and female organs will be functional, but it is also evident that they will not be simultaneously ripe. In this case the testis is much further from ripeness than is the ovary. Even although they should be ripe simultaneously, it is possible that the elements might not mix much, because there is room for the ripe eggs to collect on the opposite side of the ovary to that on which the testis is.

In the first case, where the testis is attached to the anterior end of the ovary, the former was farther from being ripe than was the ovary. It is not likely that the sperms would be able to penetrate the ovary so long as the ovary is large and distended. And as the facts indicate that the ovary will be ripe first, it is conceivable to regard the ovary as functioning later in the spent condition as a *vas deferens*.

Masterman\* described two cases of hermaphroditism in the cod in the *Thirteenth Annual Report of the Fishery Board for Scotland*, Pt. III., p. 297. He also cites a number of other cases. In none of these was a condition found similar to either of the specimens described above. In

only one case was the hermaphrodite organ symmetrical—that was a case described by Weber, in which a testis was attached to the posterior end of each ovary. In no case was the united organ composed equally of one testis and one ovary. The connection of the *vas deferens* with the ovary was similar in Howe's, Masterman's, and the present instance, except that in Howe's a well-marked valve structure prevented the back passage of ova into the *vas deferens*. A somewhat similar arrangement appeared in Masterman's specimen.

Kyle† describes a case of hermaphroditism in the ling (*Molva vulgaris*). The testis was in four parts; a very large part much larger than the ovary was attached to the anterior end of each ovary, and a smaller part was connected with the hind end of each ovary, that connected to the right ovary being very small. A small portion of the left ovary was separated from the ovary posteriorly. Anteriorly each testis opened into the ovary by a small aperture guarded against the issue of the eggs by a valve-like fold of fibrous tissue. Posteriorly the left testis opened by its *vas deferens* into the oviduct. In this specimen, then, we have a combination of the two conditions described above—viz., (1) the ovary functioning as a *vas deferens*, and (2) the common use of the oviduct for the issue of both eggs and sperms. The eggs were nearly ripe, and the testis was well developed. The specimen was secured in May.

## Plate XV.

Fig. 1.—Symmetrical hermaphrodite reproductive organs of *Gadus callarias*.

Fig. 2.—Asymmetrical hermaphrodite reproductive organs of *Gadus callarias*.

## Plate XVI.

*The Figures are not drawn to Scale.*

Fig. 1.—Symmetrical hermaphrodite reproductive organs of *Gadus callarias*.

Fig. 2.—Dissection of connection between the testis and the anterior end of the ovary in the symmetrical organ.

Fig. 3.—Diagrammatic sketch of structure of testis of preceding.

Fig. 4.—Asymmetrical hermaphrodite reproductive organs of *Gadus callarias*.

Fig. 5.—Dissection showing connection between *vas deferens* and the oviduct in the asymmetrical organ.

## LETTERS USED.

*a.*—anus.  
*b.v.*—blood vessel.  
*gn.ap.*—genital aperture.  
*gn.me.*—genital mesentery.  
*gt.me.*—gut mesentery.  
*h.c.*—honeycombed region  
*me.*—mesentery.  
*ov.*—ovary.

*ov.f.*—ovarian folds.  
*ov.int.*—interior of ovary.  
*sm.*—smooth area.  
*T.*—testis.  
*ur.*—ureter.  
*ur.bl.*—urinary bladder.  
*v.*—vessel.

\* Masterman: "On Hermaphroditism in the Cod." *Thirteenth Annual Report of the Fishery Board for Scotland*, Part III., for the year 1894, p. 297.

† Kyle: "Note on the Reproductive Organs of an Hermaphrodite Ling." *Fifteenth Annual Report of the Fishery Board for Scotland*, Part III., for the year 1896, p. 396.



FIG. 1.

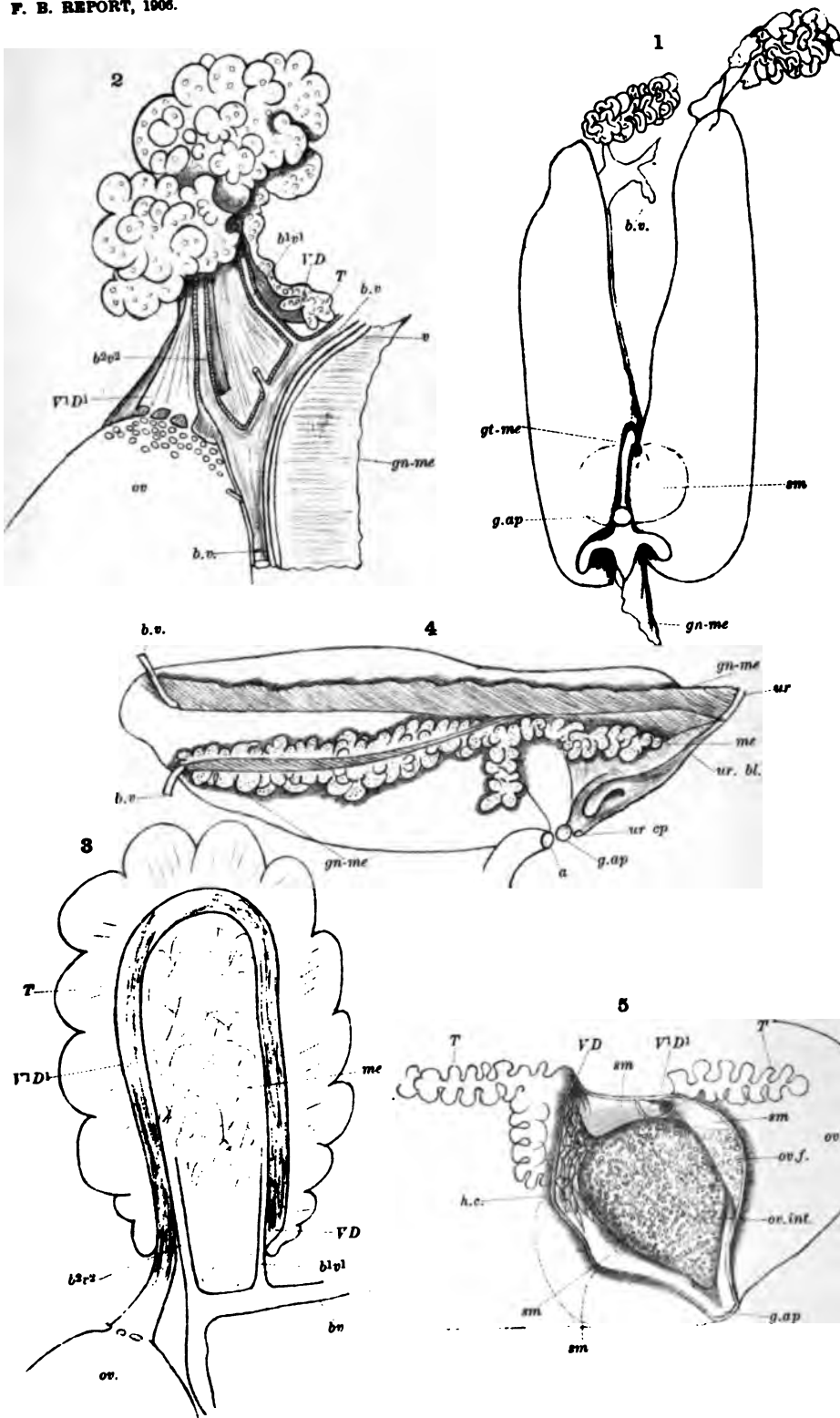


FIG. 2.

Hermaphrodite reproductive organs of *Gadus callarias*. FIG. 1.—Symmetrical Condition. FIG. 2.—Asymmetrical Condition.









XII.—ON THE GROWTH AND AGE OF THE HERRING  
(*CLUPEA HARENGUS*). By Dr. T. WEMYSS FULTON, F.R.S.E.,  
Superintendent of Scientific Investigations.

(Plates XVII-XIX.)

CONTENTS.

	PAGE.
1. Previous Opinions and Observations, ... ..	293
(a) English Authors, ... ..	293
(b) Scandinavian and Dutch, ... ..	294
(c) Meyer and Jenkins, ... ..	295
(d) Masterman and Cunningham, ... ..	298
2. The Size of the Herring when it first attains Maturity, ...	299
3. The Maximum Size attained by the Herring, ... ..	301
4. The Spawning-Periods of the Herring, ... ..	302
5. The Duration of Embryonic Development: Relation to Temperature, ... ..	303
6. A Criticism of Meyer's Conclusions and Observations, ...	304
7. The Scottish Collections, ... ..	307
(a) Larval and Post-larval Stages, ... ..	308
(b) The Annual Groups, ... ..	323
8. Conclusions, ... ..	334
9. Literature, ... ..	338
10. Description of Plates, ... ..	338

1.—PREVIOUS OPINIONS AND OBSERVATIONS.

The investigation of the rate at which the herring grows is more difficult than similar investigations with other fishes. The fact that herrings spawn twice in the year, and that spawning may take place, more or less, over many or most of the months of the twelve, offers one difficulty, and a great one, since the post-larval and young stages derived from one spawning cannot readily be distinguished from those derived from the other, though metamorphosis may occur at a different length. The conditions are complicated by the circumstance that the early stages of the sprat, which spawns in early summer, can hardly be separated with any certainty from the corresponding stages of the herring.

Many writers have expressed their opinion as to the rate of growth of this fish and the size and age it attains when it first becomes mature and reproduces; and authors are by no means in agreement on these points. It is probable that the divergence of view is in part explained by the herrings of widely-separated localities growing at a different rate, and coming to maturity at a different size; partly from the very smallest and exceptionally mature individuals having been fixed upon; many of the opinions, moreover, are based upon general considerations rather than on definite evidence.

(a) *English Authors.*

Huxley, in the report of a Commission on the Scottish herring fishery (l. p. 27) stated that it was difficult to obtain satisfactory evidence on the point, some fishermen believing that the herring took three years and others that it took seven years to reach maturity. His own view was

that there was no good evidence against the supposition that it reaches the spawning condition in one year, a view which was also held by the old Dutch naturalist Leuwenhoek. But it might be well, he said, to leave the question whether the herring attains its maturity at 12, 15, or 18 months open, in the tolerably firm assurance that the period last named is the maximum. Later, he modified his opinion, agreeing rather with Mitchell (2, p. 30) and Yarrell (3, ii., p. 190), that it attained maturity when about one year and a half old—a somewhat odd conclusion, since it implies that the summer-spawners of one year give rise to the winter- or spring-spawners of the next year but one, and *vice versa*.

De Caux, who wrote a book on the herring and its fishery, stated his belief that herrings arrived at maturity well within twelve months (4, p. 50).

Mr. George Sim did not agree with the supposition that the herring grew so fast. From the examination of large numbers of herrings, he thought that it grew in its first year six or seven inches, and that it did not spawn until the end of its second year (5, p. 46).

(b) *Scandinavian and Dutch.*

On the Continent, and especially in Sweden and Norway, much attention has been given to the question.

Ljungmann (6, 6a), as the result of the measurement of a large number of herrings in May from the west coast of Sweden, came to the conclusion that the herring grew much more slowly than the above statements would indicate.

On the coast of Bohuslän, where the small herrings come in May, they grow rapidly with the high temperature, and measure 80mm. to 100mm. He measured a great many herrings in the latter part of November on the northern part of the Swedish coast, and found that the length of these one-year-old fish varied from 78mm. to 109.5mm. In the latter part of spring he also measured many herrings on the Bohuslän coast, and came to the conclusion that the majority could be divided into three groups, (1) about 120mm. ( $4\frac{3}{4}$  inches), or one year old; (2) 170mm. to 175mm. ( $6\frac{3}{4}$ – $6\frac{7}{8}$  inches), or two years old; (3) 200mm. to 210mm. ( $7\frac{7}{8}$ – $8\frac{1}{4}$  inches), or, presumably, three years old, and with fully-developed reproductive organs.

Ljungmann occasionally found herrings as small as 18.5cm. ( $7\frac{1}{4}$  inches) with fully ripe eggs; on the other hand, many herrings from this size up to 20cm. ( $7\frac{7}{8}$  inches) could not possibly spawn the same season. While he thinks the herring spawns first at three years of age, he says some may not do so until four years old. Fish of about 23.5cm. ( $9\frac{1}{4}$  inches) he regards as four years old.

Widegren (7), who assigned a length of 75mm. (3 inches) to a one-year-old herring, and a length of 150mm. (6 inches) to one two years of age, stated that herrings two months old had a length of 25mm. (1 inch) and at three months a length of 37mm. ( $1\frac{7}{16}$  inches). The size at maturity he placed at 20cm. (8 inches) and the age at three years.

Axel Boeck (8), with special reference to the Norwegian spring herring, puts the average length when maturity is reached at 25cm. ( $9\frac{1}{4}$  inches), and the average age at three to four years; while Sundevall (9), dealing with the strömling of the eastern coast of Sweden, supposed them to attain maturity when three or four years old, and about 20cm. (8 inches) in length. He states that the young herring reach a length of 25mm. in about two months; 36mm. in three months; 50mm. in four months; 75mm. (3 inches) when one year of age, and from 125mm. to 150mm. (5–6 inches) when two years old.

The opinion of Ekström (10, 10a) was that herrings 10–12 inches in length were about 4–5 years of age. He found young herrings on the coast at Mörkö to reach a length of 25mm. in one month, 50mm. in three months, 75mm. to 100mm. in December, when they were nearly one year old, and about 100mm. (4 inches) when one year of age. He believes that maturity is reached at a length of 7 to 8 inches.

Nilsson (11) states that the young of the autumn-spawning herring measure about 75mm. (3 inches) in the following May; and, according to the views of the fishermen on the Bohuslän coast, the young of the spring herring reach a length of 25mm. in May, 50mm. about the middle of August, and in the autumn of the following year, when they are about one year and a half old, they are from 75mm. to 100mm. (3–4 inches). It was held, moreover, that the herring did not spawn until it was five or six years of age.

G. O. Sars (12) followed Nilsson in believing that the herring reaches a considerable age before it reproduces, fixing it first at 4 to 5 years, and later at 5 to 6 years.

Another author specially qualified to speak of the herrings of the Bohuslän coast assigns to them a very slow growth. A. W. Malm (13) states that those of 85mm. to 95mm. ( $3\frac{3}{8}$ – $3\frac{7}{8}$  inches) are almost two years old, and he thinks that herrings from 19cm. to 22cm. ( $7\frac{1}{2}$ – $8\frac{3}{4}$  inches) are in their fourth year, and those of 30cm. ( $11\frac{3}{4}$  inches) upwards of six years of age.

Hoek (14), who carried on a series of careful observations on the herrings of the Zuiderzee, which spawn in April and May, states that the ripe herrings measure between 24mm. and 27cm. ( $9\frac{1}{2}$ – $10\frac{5}{8}$  inches) their weight being from 110 grammes to 143 grammes, and the weight of the reproductive organs from 23 grammes to 27 grammes.

He gives a number of measurements of the post-larval and young herrings taken at various periods throughout the year. In July the smallest ones were 37mm. to 42mm. (about  $1\frac{1}{2}$  inches), and there were others between 57mm. and 80mm. or even above 90mm. In the following February most measured between 88mm. and 95mm. ( $3\frac{7}{8}$ – $3\frac{3}{4}$  inches), in March between 85mm. and 95mm., while others were 49mm. to 75mm. ( $1\frac{7}{8}$ –3 inches), others 70mm. to 78mm., and some 83mm. to 114mm. In April a few specimens were taken which measured about 90mm. ( $3\frac{1}{2}$  inches). He thinks that when one year old they are about 115mm. ( $4\frac{1}{2}$  inches); but his Tables allow a smaller size to be inferred, especially as young herrings are known to enter the Zuiderzee from the North Sea.

In another work (14a, p. 298) Hoek describes the characters of young herrings of the Hollandsch Diep and Haringvliet. Large numbers were found in the Hollandsch Diep at the end of March, measuring 45mm. to 48mm. ( $1\frac{3}{4}$ – $1\frac{7}{8}$  inches), which he assigns to the North Sea so-called winter herring, which spawns from the beginning of August on; others from 21mm. to 28mm. ( $\frac{1}{2}$ – $8\frac{1}{8}$  inches), found in the latter part of June, he attributes to the coast herrings which spawn in spring.

(c) *Meyer and Jenkins.*

A series of observations on the growth of the herring of Kiel Bay was carried on by Dr. H. A. Meyer (15, 15a), whose results are well-known and have to a very large extent guided opinion subsequently as to the rate at which the herring grows. In 1874 he found numerous larval herrings at the mouth of the Schlei, where spawning takes place in March, and especially in April and May, measuring 25mm. to 29mm. On 10th June they measured up to 33mm.; on 23rd June up to 43mm.,

but the great bulk of them had at this time a length of 25mm. to 28mm. ( $1-1\frac{1}{8}$  inches); they could not be older than three months, showing a rate of growth of at least 13mm. a month, while the majority could scarcely be older than six weeks. By the end of July they were transformed, and then measured 45mm. to 55mm. ( $1\frac{3}{4}-2\frac{1}{8}$  inches).

It is important in considering these results to note the temperature prevailing in the locality, and I append here a table compiled from those in Meyer's paper, for the ten months given; up to and including July they refer to Schliewasser, and are the mean of three years, 1875-77; for the rest they refer to Kiel Bay and are the mean of two years, 1875-76. They are all surface temperatures, and are in F.

	Mean.	Maximum.	Minimum.
March, .. ..	35·6	41·9	32·0
April, .. ..	44·2	50·0	39·2
May, .. ..	51·2	57·2	42·8
June, .. ..	62·2	70·9	51·8
July, .. ..	66·2	72·3	57·2
August, .. ..	67·1	72·7	58·1
September, ..	61·5	66·9	52·5
October, .. ..	54·5	59·7	44·2
November, ..	43·3	50·7	34·9
December, ..	36·9	44·2	32·9

On 11th June, 1874, Meyer put into a floating box at Kiel a number (not stated) of transparent post-larval herrings, measuring 25mm. to 28mm., the growth of which is shown as follows:—

Date.	No. of Days.	Length.	Increase.	Mean Approximate Growth per Day.
		Mm.	Mm.	Mm.
June 24,	13	31-33	4-7	·42
July 6,	25 (12)	37-38	5-6	·46
„ 21,	40 (15)	41-43	4-5	·30
August 1,	50 (10)	45-46	3-4	·35

The transformation of these spring herrings was completed when they were 41mm. long; and the total growth in the 50 days was about 15mm. to 17mm. ( $\frac{5}{8}-1\frac{1}{8}$  of an inch), or about 10mm. a month.

This experiment was a good one, and it would have been improved if the numbers at the different sizes had been noted. It will be seen that growth became somewhat slower towards the end of the experiment. A growth of about 10mm. ( $\frac{3}{4}$  of an inch) per month at this period, and with high temperatures prevailing, is not perhaps excessive.

At the end of August and beginning of September, Meyer also measured the young herrings in the neighbouring bays, after they had left the mouth of the Schlei and were mixed with other and larger

herrings. To obviate as far as possible the risk of confusion, he measured only the smaller herrings at the various periods (the numbers are not stated) with the following results.—

	Mm.	Inches.	Increase.
			Mm.
14th November 1876, ...	84	3 $\frac{5}{8}$	
End of November 1876, ...	90	3 $\frac{5}{8}$	6
„ December 1876, ...	100	3 $\frac{11}{16}$	10
„ January 1877, ...	110	4 $\frac{1}{8}$	10
„ February „ ...	114	4 $\frac{1}{4}$	4
„ March „ ...	135	5 $\frac{1}{4}$	21
„ April „ ...	138	5 $\frac{7}{8}$	3
	...	...	54

Thus, the total growth in about 167 days, over the winter, according to these observations, was approximately 54mm. ( $2\frac{1}{8}$  inches), or at the rate of .32mm. per day, or about 9.6mm. per month; that is to say, at about the same rate as the average growth of the smaller forms in the height of summer.

This does not agree with my experience as to the growth of other fishes, in which growth is much retarded or completely arrested, it may be, in winter, and which grow fastest in the younger stages.

Some experiments were made by keeping herrings in confinement. Two, taken on 12th August among a lot which measured from 50mm. to 55mm., were respectively 106mm. and 96mm.  $4\frac{1}{2}$  months later. The growth thus amounted to about 48mm., or about 10.7mm. per month.

Three of a medium size of 75mm. on the 24th October, kept in an aquarium, measured 100mm. on 28th December, 65 days later, or an increment of nearly .4mm. per day; at the end of January they measured 110 mm. (an increase at the rate of almost .3mm. daily), the total increase in a little over three months being 35mm., or approximately 11mm. per month.

Meyer concluded that the spring herring of the western part of the Baltic reach a length of from 130mm. to 140mm. ( $5\frac{1}{8}$ – $5\frac{1}{2}$  inches) at the end of their first year; that a month after the fertilisation of the eggs the mass of larvæ, in water over 12°C. (53.6°F.), measure from 17mm. to 18mm.; in two months, from 34mm. to 36mm., and in three months from 45mm. to 50mm., growth thereafter for the remaining months of the twelve being approximately at a similar rate of 10mm. or 11mm. per month.

Ripe herrings, both spring and autumn, were found at 20cm. ( $7\frac{7}{8}$  inches); these were the smallest, more commonly the size at first-maturity was 210mm. to 220mm. ( $8\frac{1}{4}$  to  $8\frac{5}{8}$  inches), and he states that they are got in the Baltic from 160mm. to 200mm. His conclusion is that the herring does not reach sexual maturity before the end of the second year, but this conclusion is pieced together from various considerations that appeared to him probable, and was not attained by direct evidence.

A few years later, Meyer made a number of observations on the growth of young herrings from artificially fertilised eggs (15a). The eggs were fertilised on 26th April, and before hatching they were placed in a wooden vat supplied with fresh supplies of water daily. Hatching occurred in from 14 to 15 days, the temperature being 51.8° to 53.6°F.; later in the summer the temperature of the water was about 68°F. After a few days some showed a considerable increase in size, measuring

9.2mm. and 9.3mm. Counting from the fertilisation of the egg, the sizes at different ages were as follows:—

	Mm.	Increase.	Sizes of Schlei Specimens.
		Mm.	Mm.
One Month, ...	10-11	—	17-18
Two Months, ...	17-19	7-8	34-36
Three „ ...	30-35	13-16	45-50
Four „ ...	48-54	18-19	55-61
Five „ ...	65-70	17-16	65-72

The small growth in the early stages was ascribed to deficient food, and when the arrangements were modified growth was quicker; and at the end of the five months those artificially reared were of the same size as those under natural conditions.

Another work dealing with the growth of the herring, especially of the Baltic, is by Travis Jenkins, (16), and his conclusions were founded on the examination of the otoliths of over 300 herrings, almost all from Kiel Bay, like those of Meyer. These conclusions are as follows:—

Ago.	Total Length.	Weight.	Growth in Each Year.	
	Mm.	Grammes.	Mm.	Gm.
One Year, ...	113-121	8	117	8
Two Years, ...	156-164	30	43	22
Three „ ...	190-198	50	34	20
Four „ ...	217-225	70	27	20
Five „ ...	237-245	90	20	20

With regard to the age at which the herring attains maturity, Jenkins places it at three years, when it has a length of 190mm. to 198mm. ( $7\frac{1}{2}$  to  $7\frac{3}{4}$  inches). Jenkins found that in the Windebyer Noor, a small piece of water at Eckernförde, which has scarcely any communication with the sea, and is very brackish, the mature herrings were remarkably small, though three years of age, according to the otoliths. They measured from 127mm. to 150mm. (5-6 inches), and furnish good examples of the probable effect of diminished salinity on growth, although there are other conditions in this case which may have an important influence.

(d) *Masterman and Cunningham.*

Another paper on the growth of the herring must be referred to, viz., by Masterman (17), who assigns a very moderate rate of growth to the early stages, but comes nearer the truth than some of the others whose conclusions have been quoted.

His investigation was made on a very large collection of young herrings from newly-hatched larvæ and upwards, accumulated by Professor M'Intosh at St. Andrews. They comprised both spring and autumn spawners. Enormous numbers of young herrings, just emerged from the egg, occur in St. Andrew's Bay at the beginning of March, sometimes a little earlier and sometimes a little later, and last in great abundance through April and May. Their average length is about 7mm.; when about 10mm. long they leave the bottom for mid-water, and when some 20mm. to 25mm. in length reach the surface or near it, and then migrate shorewards, frequenting the mouths of rivers. They can be traced in the same localities till mid-winter, when they have a length of some



50mm. They are not found in the spring or summer, but recur in the autumn, with a length of about 80mm., which is increased to 100mm. by the end of the year. When one year old Masterman thinks they are probably about 60mm. ( $2\frac{3}{8}$  inches) long.

In the case of the autumn herrings, the occurrence of newly-hatched larvæ extends over August and September, the spawning period being thus of shorter duration. The larvæ are somewhat shorter than the spring ones, averaging between 5mm. and 6mm.

The following Table gives Masterman's estimate of the growth from month to month of the spring and autumn herrings, after hatching:—

Month.	Spring.	Autumn.	Month.	Spring.	Autumn.
	Mm.	Mm.		Mm.	Mm.
1	15	14	8	47	43
2	20	19	9	50	47·5
3	27	23	10	54	52
4	30	27	11	58	57
5	35	30	12	62	61
6	40	34	18	87	88
7	44	38	20	98	—
			24	...	113

Thus, according to Masterman, the autumn herring at two years of age is rather smaller than the one-year old spring herring of the Baltic, as Meyer has determined it. The rate of growth of the spring series is about 4mm. to 5mm. per month, while in the winter months the growth of the autumn herring in the early stages is retarded (3mm. to 4mm. per month). The largest specimen in the collection measured 134mm. ( $5\frac{1}{4}$  inches), which would be about  $27\frac{1}{2}$  months old and belong to the autumn brood. In his later work in conjunction with M'Intosh (17a, p. 422) rather a different opinion is expressed. It is there supposed that the herring attains sexual maturity at a length of 8-9 inches and probably during the third year; and it is stated that 3 inches and 5 inches may be taken to represent a rough average of the size of a herring when one year and two years of age respectively.

The growth of the herring on the Scottish coast has also been considered by Cunningham (18, p. 162). He is of opinion that the herrings  $3\frac{1}{4}$ – $5\frac{1}{4}$  inches long (82mm. to 133mm.) taken in considerable numbers in December, in the sprat fishery in the Firth of Forth, are derived from the spring herrings that spawn at the Isle of May, which would give them an age of about nine months.

At Plymouth, a large number of small herrings from 4·3 to 5·5 inches long, taken in May, are supposed by Cunningham to be year-old fish, derived from the spawning in February and March in the previous year.

From the above review, it is apparent that very different opinions are held as to the rate of growth of the herring and the size and age when it reaches the mature condition.

## 2.—THE SIZE OF THE HERRING WHEN IT FIRST ATTAINS MATURITY.

The observations made by myself as to the size when maturity is attained lead to the conclusion that the herring on the coast of Scotland does not spawn until it has reached a larger average size than most of those given above.

Mature herrings, both male and female, are indeed occasionally taken which have a length of about 8 inches (20cm.), or even slightly under that size. I have found a few of this size at Ballantrae Bank in March with fully developed reproductive organs, but they were exceedingly exceptional. They were not quite so rare between 8 and 9 inches (20·3cm to 22·8cm.), but the great majority of these small herrings were immature.

Matthews (19, p. 96) records ripe herring from Lochfyne in February, between 19cm. and 20cm. ( $7\frac{1}{2}$  to 8 inches), and he mentions one that he examined (place and date not stated), which measured only  $7\frac{1}{4}$  inches (18·4cm.); it was the smallest among about 3000 young herrings he examined over a period of two years.

Among several thousands examined by myself, the smallest fully ripe herring measured 21·1cm. ( $8\frac{1}{4}$  inches). There were two of this size among 2178 landed in February and March, 1904, at Anstruther, in the Firth of Forth. They were thus spring herrings, and formed part of the spawning shoals which habitually visit the mouth of the Firth in spring to spawn. They were all mature fish, the spawn and milt flowing from them in February (16th), when none among the 1023 measured were spent; but on this occasion the smallest were:—Males, one at 21·8cm., three at 22·3cm., two at 25cm., two at 26cm., and altogether from 22·5cm. to 22·9cm.—21 males; females, one at 22·5cm., one at 22·6cm., three at 22·7cm., and altogether between 22·5cm. and 22·9cm. ( $8\frac{3}{8}$  to 9 inches)—there were 15 females.

In March, when 1155 were measured, 40 of the females and 43 of the males were spent; the smallest of these was a female measuring 21·5cm. ( $8\frac{1}{2}$  inches), the next spent female being 22·8cm.; the smallest male was 23cm. Among the fish still spawning, the number of each sex at the smallest measurements were these:—

	211	212	213	214	215	216	217	218	219	220	221	222	223	224
Male ...	1	—	1	1	1	3	3	3	3	3	8	10	9	11
Female ...	1	—	—	—	1	2	1	—	2	5	5	7	8	7

Moreover, among many hundreds of autumn spawners from various parts of the east coast, examined in July and August, the smallest ripe female in the latter month was 9 inches, or 23cm., the weight of the fish being 92·3 grammes, and the ovaries 13·1 grammes. It was quite an exception. The smallest male that was mature measured also 9 inches, the testes weighing 12·5 grammes.

Other particulars regarding these small herrings may be summarised. A male at 9 inches (23cm.), and weighing 110·3 grammes, was approaching ripeness, the testes weighing 9·2 grammes. One at  $9\frac{3}{8}$  inches (23·6cm.) was fully mature, as were other two at 23·5cm. and 23·8cm. One male at  $8\frac{1}{2}$  inches (21·5cm.), weighing 90 grammes, had testes which weighed 9·5 grammes, and was judged to be about half ripe.

Among small female herrings, some measuring 23·9cm. (102 grammes), 25cm. (106 grammes), 24·1cm. (128·4 grammes), 24cm. (105 grammes), and with roes weighing from 16 to 22·6 and 25 grammes, were judged to be approaching maturity. On the other hand, some females from  $8\frac{1}{4}$  to 10 inches (21cm. to 25·5cm.) were immature, their weights ranging from 93 to 133·7 grammes, and the weight of the ovaries from 2·3 grammes (in the one at 10 inches) to 1·6 and 6·4 grammes.

Besides these, there were many whose sex could not be distinguished by the naked eye. They ranged from  $7\frac{3}{4}$  to  $10\frac{1}{4}$  inches (19·5cm. to 26cm.) and from 55·5 grammes upwards, with reproductive organs from under 1 gramme in weight to 2·7 grammes.

Almost all the autumn herrings which were above 10 inches in length were ripe or approaching maturity; and it must be remembered that this was the chief spawning time.

Some particulars of other cases may be given. In the collection from the Dornoch Firth on 12th November, 1903, thirteen were examined. They ranged from 176mm. to 197mm. ( $7\frac{1}{2}$  to  $7\frac{3}{4}$  inches), and their weight from 37.5 to 57 grammes. In all cases the reproductive organ was extremely minute and immature, the heaviest (from a male) weighing 0.03 grammes. These herrings were extremely fat, and there was a large quantity of fat in the abdominal cavity. This fat, as I have elsewhere suggested, is probably used up, not only in connection with the development of the reproductive organs, but also for the production of energy, in tiding over the winter, when growth, and even the power of digestion, is to a large extent in abeyance.

Other herrings, taken in Aberdeen Bay on 29th December, measuring 148 and 153mm. (6 inches) were quite immature and were also full of fat.

In the spring herring from the Forth, as will be seen later, two series are represented, the average size of the smaller, but fully mature, fish being about  $9\frac{1}{2}$  inches, and the range from  $8\frac{1}{2}$  to about 10 inches.

I think there is little doubt that these herrings represent shoals spawning for the first time, and that the average size of the winter or spring spawner on this part of the coast, when maturity is first reached, is about 23.5cm. ( $9\frac{1}{4}$  inches), while some may spawn when about 21cm. to 22cm. ( $8\frac{1}{4}$  to  $8\frac{3}{4}$  inches), and others probably not till they are 26.5cm. or 28cm. (10 inches), agreeing in respect of variation in size with what obtains in the first mature group among other fishes. In all cases the fish in a group of the same year exhibit considerable variations in length, and it is the average rather than the extremes that have to be considered.

The mean size I have assigned to the spring herrings when they first spawn is nearly the same as has been given by Hoek for the herrings of the Zuider-zee (*supra*), viz., 24cm. to 27cm., and by Boeck for the Norwegian herring, viz., 25cm.

It is of some importance to establish the size at first maturity in connection with the consideration of the growth of the fish and the number of annual series which precede the reproductive one.

### 3.—MAXIMUM SIZE ATTAINED BY THE HERRING.

It is also desirable to say something as to the size to which herrings grow. In our waters few are caught over 12 inches (30.5cm.) in length. In those examined at Anstruther, above referred to, two were  $12\frac{3}{4}$  inches (324mm. and 325mm.), and only 33 were above 11 inches. The largest herring that came under the observation of Huxley during the enquiry in Scotland measured  $12\frac{6}{10}$  inches (32cm.), and the smallest full, it may be said, was  $10\frac{2}{5}$  inches (26.5cm.); but he mentions that the Fishery Officer stated that it was not uncommon to get Orkney herrings that measured 14 or 15 inches long, and he had got one of 17 inches (43.2cm.), a size mentioned by Buckland as the largest for a herring on record.

At Aberdeen the longest observed by Sim was  $12\frac{1}{4}$  inches (31.2cm.), its weight being  $9\frac{3}{4}$  oz.; Matthews (19) got one 33.5cm. long, and another, 33.3cm.; while Brook (20) states that in Lochfyne he has seen herrings in August "quite 15 inches long," or 37cm.

De Caux (4) records one of  $15\frac{1}{4}$  inches (39.4cm.), and Murie (21) another of  $14\frac{1}{4}$  inches (36.1cm.) The largest obtained by Ljungmanu (6)

measured 37.5cm., the largest mentioned by Collett was 36.4cm., and a herring measuring 34.4cm. was the largest found by Lundberg (22) in the Royal Museum.

Specimens of a very large size were obtained by Trybom in the course of investigations on the west coast of Sweden, and he gives very full and detailed measurements of them (23, 23a). Samples were selected from the catches of various kinds of net, and from his Tables the following are extracted. In the catches of set-nets (*sittgarnsfangst*) the largest measured 38.5, 37.0, 35.2, 34.8cm., i.e., up to 15½ inches. Here are the sizes of ten herrings from such a catch obtained at a place near Marstrand on 11th November, the meshes of the net being 35mm. (1½ inches) from knot to knot:—38.5, 35.2, 33.4, 33.4, 32.8, 32.7, 32.6, 32.5, 32.2, 32.0cm., none being under 12½ inches. With mackerel nets the sizes of the larger herrings were 36, 35.8, 35.3, and 35.2cm.; with seines (*vadfangst*) the larger measured 37.2, 35.8, 33.8cm; with purse-seines (*snörpvadfsfangst*) the largest were 34.4, 34, and 33.8cm; with drift nets, (*driftgarnsfangst*) the meshes going up to 33mm. (1¼ inches), herrings of the following dimensions were caught:—35.8, 35.5, 35.1, 35, 34.8cm., &c.

The largest herring of which I have found a record (24) is one which was said to have been taken by a Dutch herring boat (*De Dankbaarheid*) in the North Sea, about 57°23' N. Lat., on 23rd October 1863. This giant measured 48.5cm. (a trifle over 19 inches); but it was probably a shad, specimens of which are not uncommonly recorded by the unimpaired as extraordinarily large herrings.\*

The largest obtained by me in Lochfyne measured 13½ inches (33.4cm.), but many were 13¼ inches. I have also received a herring from the Firth of Forth of this size.

From general considerations I think it very probable that herrings of 14 and 15 inches represent the usual maximum size attained, and it must be borne in mind that on our east coast the herrings are all taken by drift-nets, which is selective, and that the size of mesh is small compared with those used by Trybom. In Lochfyne and the Clyde they are taken mostly by seine-nets.

#### 4.—THE SPAWNING PERIODS.

There are two well-marked periods of spawning on the coast of Scotland, one in spring and one in autumn. The former is chiefly in March and February, as at Ballantrae Bank in the Clyde, and at the mouth of the Firth of Forth; the latter is chiefly in August and September.

Mr. Jeffrey, the Fishery Officer at Peterhead, who has had great experience, tells me that on this part of the east coast (Aberdeenshire) the autumn and summer spawning season varies very little, and that the principal time may be safely set down as extending from the middle of August to the end of the first week in September, though small shoals may spawn a little before and a little after the period stated. With regard to the winter or spring fishing, very little is done on the Aberdeenshire coast, but the fishermen agree that the herrings taken in January and February are well developed, and that they spawn in March.

This is also the experience at Ballantrae and the Firth of Forth, and I think March may be set down as the chief spring month for spawning, though it extends from the latter part of January into April. It is probable that the height of the spring spawning is separated from the height of the autumn spawning by something less than six months,

\* Dr. Redeke, Scientific Adviser on Fisheries to the Dutch Government, kindly informs me there is no evidence that the fish was examined by a competent person, and he does not attach any value to the record.

and the latter from the spring spawning in the following year by rather more than six months.

Too much stress perhaps is laid on the fact that spawning herrings may be obtained in most months of the year. There is evidence to show that among several other fishes individuals may be found fully mature at times more or less remote from the spawning period. On some parts of the coast, moreover, the limits of the normal spawning period of the herring may be earlier or later than what I have stated. But that the spawning season is a brief one, both in spring and autumn, is shown by the separation of the age-groups, contrasting in this respect with most other species.

#### 5.—THE DURATION OF EMBRYONIC DEVELOPMENT: RELATION TO TEMPERATURE.

The period of "incubation," from the deposition and fertilisation of the eggs until the young herrings hatch out, varies according to the temperature of the water, which appears to be by far the most important factor. It is desirable to consider the point, because it furnishes a clue to the period when the mass of the larvæ escape into the water and begin independent life and growth.

Many observations have been made as to the hatching of the eggs of the herring at different temperatures, and I append a Table in which I have set down a number of them.

Place.	Season.	Temperature. F.	Number of Days to Hatch.	Authority.
Firth of Forth,	February, March,	(40-41)	25-30	Allman.
Clyde, . . . .	March, . . . .	41-44	18-22	Ewart.
" . . . .	March-April, . .	(40-45.5)	26	Dannevig.
Plymouth, . . .	January, . . . .	48	12-14	Cunningham.
Zuiderzee, . . .	April, . . . .	48.9	12	Hoffmann.
Bohuslän, . . .	Spring, . . . .	—	24	Malm.
Norway, . . . .	Spring, . . . .	—	24	Boeck.
Stockholmlän, .	— . . . .	—	14	Sundevall.
Mörkö, . . . .	— . . . .	—	14	Ekström.
Northumberland, .	August, . . . .	52-58	8-9	Cunningham.
Denmark, . . .	— . . . .	—	8-10	Krøyer.
Clyde, . . . .	September, . . .	54	8-10, 13	Ewart.
Stockholmlän, .	August, . . . .	57-59	6-8	Sundevall.
Kiel, . . . .	Autumn, . . . .	50-51	11	Meyer.
" . . . .	Spring April, . .	64.4-68	8-10	"
" . . . .	" " . . . .	51.8-53.6	11	"
" . . . .	" " . . . .	35.6	28-34	"
" . . . .	" " . . . .	32	47	"

The last entries refer to experiments by Meyer.

It is obvious from the Table that the period of "incubation" varies greatly, and that in the case of spring or winter spawners the duration is much longer than with the autumn-spawning fish.

At the spawning-grounds near the mouth of the Firth of Forth the temperature of the bottom water in the various months is as follows :—

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Surface, .	41.6	40.9	40.1	43.1	46.8	51.2	54.1	55.1	54.1	51.3	47.8	44.4
Bottom, .	42.8	41.0	39.9	41.9	44.8	46.6	50.0	52.9	53.1	51.4	48.6	45.2

It has been mentioned by Huxley (1) as a point of interest that he met with no case of full or spawning herrings during the solstitial months, viz., June and December; but it is perhaps of more interest to note that

the spring herrings spawn when the bottom water is the coldest of the year and the autumn spawners when it is the warmest of the year.

The effect of the difference on the rate of development in the eggs must be considerable. From the Table given above it may be inferred that the eggs of the spring fish take from about 25 to 30 days to hatch in February and March, while the eggs of the autumn spawners hatch in 9 or 10 days, or approximately in a third of the time. One must therefore add these numbers to the date fixed for the maximum spawning in order to determine the period when most of the larval herrings appear in the water. In the case of the spring fish the period is about the middle of April, and in the case of the autumn fish it is about the second week of September.

The advantage to the autumn herring in respect of the quicker development in the egg is, however, compensated by the difference in the temperature to which the young growing herrings are soon exposed. With the spring fish the temperature is a rising one, favourable to growth, for many subsequent months, while with those hatched in autumn, the temperature is a falling one, especially at the surface, and thus less favourable to growth.

How long it may take in some instances for the young of the spring herring to reach even a small size is shown by an experiment of Mr. Harald Dannevig. On 13th–14th March he fertilised some herring eggs and brought them to the Marine Laboratory at Aberdeen, where they hatched on 9th April, after an "incubation" period of 26 or 27 days. The larvæ then measured 8mm. in length. The yolk was not absorbed until 9 days later, and 23 days after hatching the post-larvæ measured only 10mm. In this case 49 or 50 days elapsed (viz., 13th–14th March–2nd May) before the young herring measured  $\frac{3}{4}$ -ths of an inch, thus offering a great contrast to the results of Meyer, but in the latter case the temperature during the experiment was not the same as at Aberdeen. Much stress cannot be put upon the experiment, but Mr. Dannevig is skilful in rearing post-larval fishes, as his success with the plaice shows.

The difference in temperature between the bottom and surface water, above shown, no doubt explains the fact that the larvæ in spring soon seek the upper layers, while in autumn they do this to a very small extent, the later larvæ, as Masterman says, appearing never to leave the bottom, but to migrate shorewards at once, without an intermediate journey through the mid-water and surface layers.

The young herring when it is hatched is of a length ranging from 5.2mm. to 8.8mm. ( $\frac{1}{4}$ – $\frac{3}{4}$  inch), and the yolk disappears in from three or four days to a week; traces may be found in larvæ measuring over 9mm.

It may be mentioned that the larva of the sprat is 3–3.7mm. when hatched, and, according to Ehrenbaum, the length when the yolk is absorbed (in about a week) is 4.7mm. They may thus be easily separated in some collections.

#### 6.—A CRITICISM OF MEYER'S CONCLUSIONS AND OBSERVATIONS.

Before dealing with the collections of herrings given in the Tables appended to this report, it may be well to consider some general results as to the growth of fishes deduced from my researches with a number of other species, and how they bear upon the statements concerning the growth of the herring above quoted, and more especially those of Meyer and Jenkins.

Meyer, as we have seen, came to the conclusion that the herring at the end of about six months reached a length of approximately 70mm. to 80mm.; at the end of the first complete year a length of 130mm. to 140mm., and at the end of the second complete year, when he supposed it to attain to maturity, a length of 160mm. to 170mm.

The amount of growth in length in the first year was thus 130mm. to 140mm. ( $5\frac{1}{2}$ – $5\frac{1}{2}$  inches), while in the second, and, be it noted, before sexual maturity, it was only 30mm. ( $1\frac{3}{8}$  inches). In other words, about 82 per cent. of the growth in the period anterior to sexual maturity is represented as occurring in the first half of the period and only 18 per cent. in the second half, a result totally opposed to what happens with other fishes.

Jenkins, as we have seen, also working on the herrings of Kiel Bay, by studying their otoliths, reduces somewhat the rapidity of growth as brought out by Meyer. He makes the sizes of the annual groups somewhat less than Meyer, and puts the period of maturity at the third year instead of the second, increasing the size at first maturity by some 3·0cm. He also gives the annual sizes up to the fifth year, when the herrings are between 9 and 10 inches in length. Thus, taking the average sizes as given by Jenkins, we have the following increments per annum before maturity.

Year.	Mean Size.	Increment.	Percentage Increase on Total Length at Maturity.
	Mm.	Mm.	
1, . . . .	117	117	60·3
2, . . . .	160	43	22·2
3, . . . .	194	34	17·5

Again, if we consider the growth each year as related to the total growth in the five years as given by Jenkins, we have the following:—

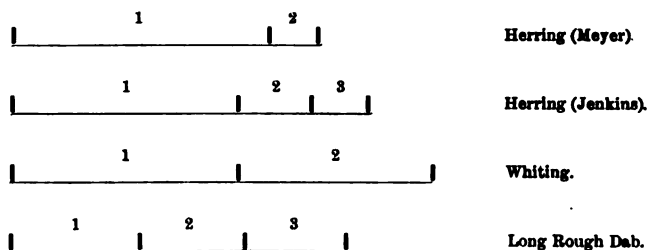
Year.	Mean Length.	Annual Increment.	Percentage Increase on Total Length at 5 Years of Age.
	Mm.	Mm.	
1, . . . .	117	117	48·5
2, . . . .	160	43	17·8
3, . . . .	194	34	14·1
4, . . . .	221	27	11·2
5, . . . .	241	20	8·3

Thus, according to these results, the herring grows in its first year (though not sexually mature till its third year) almost half of the total length it attains at the end of its fifth year.

The conclusion, I think, is obvious, that both Meyer and Jenkins have jumped at least a year, and that the herring at 135mm. or 117mm. is much more than one year old.

We are now tolerably well acquainted with the growth of several species of fish, and in all of them the growth in each year *anterior to the occurrence of sexual maturity* is fairly comparable in extent; very often the amount of growth in the first year is somewhat greater than in the others, and it diminishes slightly with each successive year; though observers do not always agree about this.

The difference referred to may be brought out by the following diagram, showing in proper relation the annual growth of the long rough dab and whiting up to sexual maturity, and of the herring according to Meyer and Jenkins up to the same period.



Meyer's methods of determining the size of the herrings living naturally in the sea were unsatisfactory, and were unlikely to furnish a just estimate of the average size or of the true rate of growth, and his experiments are subject to important reservations, since only selected results are given, and not full details or numbers; and, moreover, too much stress was laid on the amount of growth in the summer months as a factor in computing the amount of growth for the whole year.

Thus, the growth of the herrings in the Schlei, as determined by him for comparison with his later rearing experiments, amounted to only 48-54mm. ( $1\frac{7}{8}$ - $2\frac{1}{8}$  inches) over the five summer months, or an average of just 10mm. per month, and the herrings which he reared grew to a similar extent over the period. But the temperature in these months is the highest in the year, the means ranging from 51·2 F. for May to 67·2 F. for August, and in no other month, except May, was it under 61·5 F. Then, again, in the best of his experiments, in which the young herrings were kept in a floating box for 50 days, the growth was at the mean rate of 9·6mm. ( $\frac{3}{8}$  of an inch) per month, but the months were at the end of June and July, the mean temperature in the latter month being 66·2 F.

Compare these reasonable results with his results in winter, derived from the comparison of herrings from the sea, as shown in another Table. We find that from the end of November to the end of March (when with many fishes growth is quite arrested and always very slow) the indicated growth in the four months, December to March, amounted to 48mm., or 12mm. a month, which is higher than in summer, a result that is obviously fallacious. And yet the average size when a year old is placed at 135mm., a size which appears to have been inferred from five months' growth at 10mm. per month and seven months' growth at 12mm. per month.

In point of fact, as shown in my various papers on the rate of growth of fishes, as in the one in the present report, growth in summer greatly exceeds the growth during the rest of the year, while it is extremely small in the period from October-November to February-March.\*

\* Here are a few examples. The growth of young haddocks from 31st July to 10th September (41 days) amounted to 38·6mm., or at a rate of ·94mm. per day, or 29mm. per month; from 31st July to the 18th October (79 days) they increased by 61·1mm., or at a rate of ·77mm. per day, or about 24mm. per month; over part of winter, from 28th November to 15th January (48 days) the increase was 3·7mm., or at a rate of ·08mm. per day, or 2·4 per month. Another series increased by 28·6mm. in the 41 days from 24th July to 3rd September, the rate being ·7mm. per day, or 21mm. per month. Over winter and spring another series increased in 164 days, from 18th December to 30th May, by 33·9mm., or at a rate of ·2mm. per day, or 6·4mm. per month, and the period included April and May, which is one of the most favourable months.

With the young whiting, whose habitat more nearly resembles that of the young herring, the retardation in winter and the rapid growth in summer are marked. From June to the middle of September one set of observations shows a growth of ·5mm. per day, or 15·8mm.



In the shallow waters on the beach, it may be entirely arrested, as with small flat-fishes, while the growth of young whiting is very greatly diminished—it grows at least fifteen times faster in the summer months. Young herring inhabit the same coastal waters, and must be affected in a similar way; and an estimate of the average size of the one-year old herring from Meyer's own observations above referred to, qualified by these facts, would reduce the size very materially.

I think there is little doubt, at all events, that Meyer's conclusions as to the rate of growth of the herring, which have so long held the field, are fallacious.

Jenkin's results are based on a study of the otoliths, which, as he says, cannot tell the precise age of a fish, but only within certain limits. So far as my somewhat limited experience goes as to the utility of the markings on the otoliths of the herring as a clue to the age of the fish, it has led me to the belief that there is considerable scope for erroneous conclusions, especially with the younger forms. It appears to me probable, on the above grounds alone, that Jenkins has not succeeded in separating the first year's fish from the second year's, and that the size he gives as approximately that of a one-year-old (117mm.) is nearer the size of a two-year-old herring.

His observations on the older herrings are valuable, and it is of interest to note that he makes a herring of 21·7cm. to 22·5cm. ( $8\frac{1}{2}$  to  $8\frac{3}{4}$  inches) approximately four years old, and one of 23·7cm to 24·5cm ( $9\frac{3}{8}$  to  $9\frac{5}{8}$  inches) approximately five years old.

He gives an interesting diagram (16, p. 95) of the curves based on the determinations of different observers. The point alluded to, the exaggeration of the first year's growth, is well indicated, and the curve exhibiting Meyer's results shows a deflection at the end of the first year which would not apply to any other fish.

The curves of Ljungmann (who calculated the year-old herring to be from 65cm. to 90cm in length) are devoid of this, except between the second and third year,† and it is noteworthy that the prolongation of the curve of Ljungmann and of the curve showing Masterman's conclusions meet Jenkin's curve in the fourth year.

#### 7.—THE SCOTTISH COLLECTIONS.

The collections have been made during the last five or more years at various seasons, and mostly in Aberdeen Bay, the Moray Firth, and the Firth of Forth.

The measurements arranged in .5 centimetre groups are given in Tables I.–III., appended to this paper.

per month; another from 30th May to the early part of October show increments of .5mm. per day, or 15·8 per month; another in July and August show increments of .9mm. per day, or 28·5 per month; a fourth set show increments in June and July of .66mm. per day, or 20·5 per month. On the other hand, in the winter and spring, we have the following:—From 21st December to end of May an increase of 17·1mm., or at a rate of .107mm. per day, or 3·4mm. per month—most of this, no doubt, in May; 18th October to 15th January, .045mm. per day, or 1·4mm. per month; 6th November to 17th December, 1·5mm., or .037 per day, and 1·1mm. per month; 29th November to 15th January, 2·3mm., or .048mm. per day, or 1·4 per month. These observations are based on the measurements of many thousands of fish.

In the deeper water it may be shown that the growth in the early months is less retarded, as with haddock, whiting, and witches, and no doubt also with mackerel and other fishes, which withdraw to the deeper and warmer layers in winter, but, as elsewhere remarked, there are not yet sufficient temperature observations with which to correlate the observations on growth, those taken on the Quarterly Cruises in the International Investigations being useless for fishery investigations such as these.

† Due to misapprehension of his measurements, a mistake also made by Meyer, who took Ljungmann's measurements as measurements of the total length, whereas they excluded the caudal fin.

## (a) Larval and Post-Larval Stages.

Considerable collections of larval and small post-larval clupeoids and herrings were obtained by the "Garland" during the years she was engaged in the Forth and adjoining waters, which have been tabulated in the Board's Reports\* by various workers. In Professor M'Intosh's tables† referring to the pelagic fauna of St. Andrews Bay, various young clupeoids are tabulated, and a large number also in the paper by Masterman previously mentioned.

It is important to determine the rate of growth of the herring in the early stages, first of all, and I have therefore brought together in the table subjoined most of the measurements contained in the lists referred to, those given by Masterman in his paper and by M'Intosh in his tables, as well as those in the later collections of the Fishery Board. M'Intosh states that towards the end of March myriads of young clupeoids, apparently herrings, through the lower part of the water in St. Andrews Bay. They had probably only escaped from the eggs, though the absence of the yolk-sac in many, and the presence of well-marked embryonic fin-rays, showed that they were some days old. He also states that in this month numerous young sprats, from  $1\frac{3}{8}$  to  $1\frac{1}{2}$  inches (34mm. to 45mm.), were captured in the mid-water net.

A précis of the collections examined by Masterman shows the following:—

In *January* (19th, 20th) eleven herrings measured from 42mm. to 56mm., the average size being 48mm. to 49mm. ( $1\frac{1}{2}$  inches). According to Masterman's tables showing the increments of growth per month, these are much too large to be the autumn herrings of the year before, which at the period would measure, on his scale, only about 30mm., or less; and they correspond rather to the spring herrings of the previous year, which at nine months would be about 50mm., and this would take them back to May; if referred to April, they ought to be about 54mm. They cannot be sprats, for, apart from diagnosis at that stage, the sprats in March, as stated above, measure only 34mm. to 45mm. The evidence obtained by myself supports the view that they are the herrings of the previous spring.

In *February* (19th) nine herrings from 35mm. to 41mm. ( $1\frac{3}{8}$  to  $1\frac{1}{2}$  inches), and with a mean size of 37.3mm. ( $1\frac{1}{2}$  inches), were caught.

On 1st *March* eleven, from 33mm. to 39mm.; on 7th–21st, ten, from 26mm. to 44mm.; and on 31st, one of 40mm., were taken, making altogether for the month, 22, from 26mm. to 44mm., with a mean of about 35mm. ( $1\frac{3}{8}$  inches).

In *April* (2nd–18th) twelve measured from 32mm. to 49mm. (all but the two smallest on 18th), the average being 42.3mm. ( $1\frac{1}{2}$  inches).

All these were quite distinct from the young herrings that appear about this time, to be referred to below, and with these we have the following larger forms, viz.—(1) 14th to 31st *March*, seven herrings, from 79mm. to 103mm., with an average length of 95.6mm. ( $3\frac{3}{4}$  inches), and on 29th *April* one at 110mm. ( $4\frac{3}{8}$  inches).

In *January–March* we have thus three groups of these older clupeoids—(1) Those in *January*, with an average of 48mm. to 49mm., belonging to the previous spring; (2) in *February, March, and April*, a group

\* 8th, p. 270; 9th, p. 334; 10th, p. 300, by Professor M'Intosh; and the others in the 11th, p. 250; 12th, pp. 298, 300; 13th, p. 258; 14th, p. 223; 15th, p. 246, by Masterman, Tosh, Williamson, Wallace, and Kyle.

† *Ibid.*, 7th, p. 287; 11th, p. 284.

from 26mm. to 49mm., derived from the previous autumn; and (3) in March a group from 79mm. to 103mm.

According to the rate of growth deduced by Masterman, the larger herrings, measuring about 96mm., would be approximately 19 to 20 months old, which would refer them back to the autumn fish, two years before.

In March, as mentioned above, the larval herrings begin to appear. The earliest in the tables is 3rd March. From 3rd to 7th, five measured 5mm. to 8mm.; on 14th, 135 measured from 6mm. to 9mm.; from 26th to 31st, 5804 measured from 6mm. to 11mm., the range during the month being from 5mm. to 11mm. Great hauls were taken on 30th March 1889, so much so that the bottom-net had to be disused. In April, from 2nd to 11th, 716 measured from 6mm. to 11mm.; from 11th to 21st, 108 were from 7mm. to 14mm.; from 21st to 28th, 39 were from 5mm. to 16mm., the progress in growth being shown by the larger sizes, the maximum for the month being 16mm. ( $\frac{5}{8}$  inch), and the range from 5mm. to 16mm. In this month, however, a complication is introduced by the appearance of larval sprats.

Up to April, and well into that month, there seems to be little or no difficulty, owing to the limit of the spawning period of the sprat. Masterman, in describing the pelagic eggs collected by the "Garland" over a series of years,\* states that the extreme limits of the spawning period of this fish, as inferred from the eggs obtained, were from 23rd March to 19th August, both in the same year (1891). The earliest dates in other years were 6th, 14th, 17th, 24th April, and at first very few were got. The chief spawning time is from the middle of May on towards the end of June.

It would be remarkable if all the early post-larval sprats were separated from the early post-larval herrings, and from the latter part of April the possibility of this disturbing factor has to be considered. From the Table given below, however, it appears that this disturbance cannot be serious, for in the months when sprats ought to be appearing in greater numbers (June-July) clupeoids are remarkably scarce.

On May 2nd five clupeoids measured from 10mm. to 17mm. ( $\frac{3}{8}$  to  $1\frac{1}{8}$  inches), and are clearly herrings; in the period 14th to 31st, 28 measured from 5mm. to 25mm., but there appear to be again two groups, viz.—13 from 5mm. to 8mm., and 15 from 13mm. to 25mm., which show the continued growth of the young herring; at the end of May the herrings are 17mm. to 22mm. (up to  $\frac{7}{8}$  inch), and as the one at 25mm. was taken on 16th, it is probable the limit is greater and slightly exceeds one inch.

The herring at this period and size may be approaching three months of age. At a nearly corresponding stage, Meyer's Baltic herrings (but at the end of July, with higher temperatures) were 30mm. to 35mm. ( $1\frac{3}{8}$  to  $1\frac{5}{8}$  inches); those in the sea, as he inferred, being 45mm. to 50mm.

In June (9th, 10th) only three were got; one at 13mm., the other two measured 20mm.

In July (9th) two alone of the smaller were caught, measuring 16mm. There are, however, a series of 25, extending from 28mm. to 37mm., the average size being 32.1mm ( $1\frac{1}{4}$  inches). These can only be regarded as the spring herrings, now over three months, and it may be four months old—months, too, very favourable for growth.

There are four other herrings which were taken on the same date, viz., one 57mm., two 59mm., and one 75mm., the mean being 62.5mm. ( $2\frac{1}{4}$  inches). They probably do not belong to the same group, and it is

\* *Fifteenth Annual Report*, Part III., p. 233.

worth considering their origin. They could scarcely belong to the spring fish of the year, whose growth, as we have seen, is much slower; the two smaller might be referred to the previous autumn, and would thus be approximately ten months old; the one at 75mm. (almost 3 inches) is to be referred to the spring of the preceding year. According to the rate of growth given by Masterman, herrings of that average size, if spring herrings, would be almost exactly twelve months old, and if autumn herrings, all but twelve months old (61mm.).

It is, however, to be remarked that herrings of this size and larger are likely to escape from tow-nets, especially when used in daylight, and even from the slowly-towed and larger midwater net; and thus the average size of the herrings, except the smaller ones in collections obtained in this way, may be expected to be somewhat under rather than to exceed the true natural size for the group.

If the two smaller belong to the same group as those which had an average length of 42.3mm. on 18th April, the increment in the 82 summer days would amount to 15.7mm., or a mean of .19mm. per day, or 5.9mm. ( $\frac{1}{4}$  inch) per month.

In *August* we come again on the larval clupeoids. M'Intosh mentions them under date 2nd, from 5.5mm. to 8mm. In Masterman's tables, seven from 5mm. to 11mm. are entered between 3rd and 9th; also two at 15mm. and one at 20mm. From the 22nd to the 30th, 71 measured from 4mm. to 12mm., and one was 19mm., possibly to be referred to the spring series. Omitting the larger, the average for the 71 at the end of August was 6.7mm. This may be taken as the size at which the autumn herring starts the beginning of September.

In *September* M'Intosh notes the appearance of clupeoids from 7mm. to 13.5mm., the latter size only after the middle of the month. In the table of Masterman, 184 are entered between the 4th and 7th, of which 181 measure from 4mm. to 9mm., and are mostly 6mm.; one is 13mm., and two are 44mm. ( $1\frac{3}{4}$  inches), and no doubt represent the herrings hatched in March or April.

From 13th to 30th there are 70 in two series, (1) 64 from 5mm. to 18mm. and mostly about 11mm., (2) 6 on 17th from 36mm. to 40mm., the average being 39.0mm.; if these are combined with the two taken earlier, the range is from 36mm. to 44mm., and the average size 40.2mm. ( $1\frac{5}{8}$  inches).

These are no doubt the spring herrings, which show an increment of 8.1mm. (under  $\frac{3}{8}$  inches) in the 68 days (approximately) from the series of 9th July, or only .12mm. per day.

On the 7th September two other larger herrings were taken, measuring 75mm. and 80mm. ( $3, 3\frac{1}{8}$  inches), which no doubt represent the older series taken in July.

In *October*, from the 1st to 9th, 34 measuring 7mm. to 19mm., and mostly about 13mm. to 14mm., are entered; from 11th to 19th, there are 82, in three groupings, (1) 4 at 6mm.—indicating a late spawning—(2) 66 from 12mm. to 20mm., most about 17mm. ( $1\frac{1}{4}$  inches) representing the average size at this period, and (3) 12 from 32mm. to 41mm., taken on the 16th and 18th, the average length being 33.2mm. ( $1\frac{1}{4}$  inches), or less than those taken a month earlier. These probably represent the spring herrings.

In *November*, the number is greatly diminished. From the 1st to the 8th, 14, from 14mm. to 24mm., and averaging 17.3mm. were taken; and from the 16th to the 24th, other four, from 19mm. to 26mm., the average length for the 18 specimens being 18.3mm. (barely  $\frac{3}{4}$  inches), which approximately represents the size of the autumn herring in November, some specimens, however, attaining a little over 1 inch.

In December, only four of this series were taken, viz., on the 3rd, and they measured 15mm. and 17mm. There were also four at 37mm., or almost an inch and a half, probably spring fish, as well as one at 100mm., and another at 134mm.

It seems probable, therefore, from these observations that towards the end of the year the average size of the young autumn herring, when three to four months old, is under 20mm. ( $\frac{3}{4}$  of an inch), and probably not much over  $\frac{5}{8}$  of an inch; some measure 26mm., or slightly over one inch.

The spring herring, which is, however, 1mm. to 2mm. longer when it issues from the egg, grows quicker, and may even reach, as we saw, a length of an inch at the end of May, when they are relatively younger. This is associated with a favourable and rising temperature, and probably better food supplies, since M'Intosh found traces of diatoms in them in March (25 g, 267), and also Dr. George Murray (26), who found *Coscinodiscus* abundant in small post-larval clupeoids.

From these tables of Masterman it would appear that the growth of the herring in its post-larval stages is much slower on the east coast of Scotland than Meyer found it to be at Kiel.

"GARLAND'S" COLLECTIONS OF CLUPEOIDS.

Mm.	Jan.	Feb.	Mar.	April.	May.	June.	July.	August.	Sept.	October.	Nov.	Dec.
4-5			X	X	X	X	X	X	X	X		
6-7		A	X	X	C	X	X	X	X	X		
8-9			XXXX	XXXX	XXXX		X	XX	XX	X		
10-11			XXXX	XXXX	XXXX		X	XX	XX	XX		
12-13			XXXX	XXXX	XXXX		X	XX	XX	XX		
14-15			XX	XX	XX		X	XX	XX	XX		
16-17			XX	XX	XX		X	XX	XX	XX		
18-19				X	X		X	XX	XX	XX		
20-21				X	X		X	XX	XX	XX		
22-23				X	X		X	XX	XX	XX		
24-25		B	X	X	X		X	XX	XX	XX		
26-27	X		X		X		X	XX	XX	XX		
28-29		X	X				X	XX	XX	XX		
30-31		X	X				X	XX	XX	XX		
32-33		X	X				X	XX	XX	XX		
34-35		X	X				X	XX	XX	XX		
36-37		X	X				X	XX	XX	XX		
38-39		X	X				X	XX	XX	XX		
40-41		X	X				X	XX	XX	XX		
42-43	X		X				X	XX	XX	XX		
44-45	X		X				X	XX	XX	XX		
46-47	X		X				X	XX	XX	XX		
48-49	X		X				X	XX	XX	XX		
50-51	X		X				X	XX	XX	XX		
52-53	X		X				X	XX	XX	XX		
54-55	X		X				X	XX	XX	XX		
56-57	X		X				X	XX	XX	XX		
58-59	X		X				X	XX	XX	XX		

The Table embodying the references to the collections of the *Garland* and the above measurements shows generally the same features.

One sees the various groups, the spring series and the autumn series, as well as the older ones (B). At A, there is no doubt about the clupeoids representing the herring, but later, as at C, the sprat is doubtless present, and the smaller fishes represented in July may also be sprats.

In the Tables and curves appended to this paper (Tables I.-III., Plates XVII.-XIX.) it will be seen that the groups of herrings are well separated from one another, comparatively little admixture of the spring and autumn herrings taking place—though it does occur—and the elucidation of the rate of growth of the herring would be an extremely simple matter if it were not for the existence of these two series, one derived from spring and the other from autumn.

In dealing with the post-larval herrings, I have had the advantage of Dr. Williamson's experience in their diagnosis, and I have to thank him for his assistance in this respect and for measuring a number of these collections.

Place and Date.	Depth.	Series.	Number.	Range in Size.	Difference.	Average Size.				Origin.	Probable Age.
						Modal.	Mean.	Arithmetical.	Inches.		
<b>Aberdeen Bay.</b>	Fms.			Mm.	Mm.	Mm.	Mm.	Mm.			Mths.
11th Feb. 1905	8-12	III.	3	100-115	..	..	..	..	..	..	..
29th March 1905	18-25	V.	1	125	..	..	..	..	..	..	..
	..	..	3	165-195	..	..	..	..	..	..	..
24th April 1906	4-6	II.	167	41-46	5	43.5	43.5	43.5	1 $\frac{1}{2}$	A	8
30th May 1901	12-16	IV.	598	142-186	44	159	164	162	6 $\frac{1}{2}$	S	38 $\frac{1}{2}$
	..	..	3	196-228	..	..	..	..	..	S	50 $\frac{1}{2}$
June 1904	..	II.	24	50-60	10	55	55	55.8	2 $\frac{1}{2}$	..	..
19th June 1900	1	II.	15	55-65	10	60	60	..	2 $\frac{1}{2}$	..	..
13th June 1903	8-10	IV.	523	118-163	45	138	140.5	141.8	5 $\frac{1}{2}$	A	33
	..	V.	30	164-182	..	..	..	..	..	S	..
	..	..	4	208-234	..	..	..	..	..	..	..
28th June 1901	12 $\frac{1}{2}$	IV.	650	148-192	44	167	170	168.9	6 $\frac{1}{2}$	S	30 $\frac{1}{2}$
5th July 1901	10	IV.	8	140-164	24	140	150	149.2	5 $\frac{1}{2}$	..	..
18th, 20th Sept. '00	2-3	I.	194	21-44	23	33	32.5	34.3	1 $\frac{1}{2}$	S	6
2nd October 1901	10	I.	297	9-20	11	..	..	15	$\frac{1}{2}$	A	1-1 $\frac{1}{2}$
3rd October 1901	..	I.	334	8-27	19	17	17.5	16.2	$\frac{1}{2}$	A	1-1 $\frac{1}{2}$
18th October 1901	7-10	II.	1	85	..	..	..	..	..	..	..
	..	III.	429	96-141	45	115	115	117.5	4 $\frac{1}{2}$	A	25
	..	IV.	14	143-187	44	..	..	..	..	..	..

S=Spring.

A=Autumn.

Place and Date.	Depth.	Series.	Number.	Range in Size.	Difference.	Average Size.				Origin.	Probable Age.
						Modal.	Mean.	Arithmet.	Inches.		
<b>Aberdeen Bay—con.</b>	<b>Fms.</b>			<b>Mm.</b>	<b>Mm.</b>	<b>Mm.</b>	<b>Mm.</b>	<b>Mm.</b>			<b>Mths.</b>
31st October 1900	8-10	II.	650	52-95	43	80	73	77.8	3 $\frac{1}{2}$	A	14
	..	III.	179	96-143	47	100	..	..	..	..	..
	..	..	1	167	..	..	..	..	..	..	..
6th November 1903	54-12	I.	181	12-25	13	19	17.5	18.2	4 $\frac{1}{2}$	A	2
	..	..	6	132-143	11	..	..	137.5	..	..	..
	..	..	2	185-188	..	..	..	..	..	..	..
6th November 1901	6-13	II.	3	86-95	..	..	..	90.3	..	..	..
	..	III.	24	102-132	30	110	110	116.2	4 $\frac{1}{2}$	..	..
9th November 1900	9	II.	4	75-100	..	..	..	85.7	3 $\frac{1}{2}$	..	..
	..	III.	18	116-143	..	..	..	132.6	5 $\frac{1}{2}$	..	..
23rd Dec. 1903	..	I.	6	23-36	13	..	29.5	..	1 $\frac{1}{2}$	A	2 $\frac{1}{2}$
12th Dec. 1903	5-10	I.	15	42-50	8	45	46	46.5	1 $\frac{1}{2}$	S	9
	..	..	6	97-124	27	..	110.5	109.3	4 $\frac{1}{2}$	..	..
17th Dec. 1901	94-15	III.	47	103-147	44	122	125	122.1	4 $\frac{1}{2}$	A	27
	..	..	3	146-157	..	..	..	..	..	..	..
18th Dec. 1900	8	..	4	109-112	..	..	..	..	..	..	..
	..	III.	405	114-161	47	141	137.5	135.0	5 $\frac{1}{2}$	S	33
	..	..	1	165	..	..	..	..	..	..	..
19th Dec. 1900	6-8 $\frac{1}{2}$	II.	6	78-95	17	..	..	90.5	3 $\frac{1}{2}$	..	..
	..	..	5	110-131	21	..	..	120	4 $\frac{1}{2}$	..	..
20th Dec. 1903	5-12	..	16	108-134	46	124	131	128.8	5 $\frac{1}{2}$	..	..
<b>Dornoch Firth.</b>											
9th Feb. 1905	64-12	III.	8	104-122	18	113	113	112.4	4 $\frac{1}{2}$	S	24
31st March 1904	5-10	III.	16	106-136	30	112	121	117.6	4 $\frac{1}{2}$	S	24
13th Nov. 1903	..	I.	166	13-26	13	20	19.4	19.5	2	A	2 $\frac{1}{2}$
21st Oct. 1903	8-12	I	28	14-20	6	17	17	16.8	4 $\frac{1}{2}$	A	2
5th Nov. 1900	7-10	II.	48	73-97	24	93	86	90	3 $\frac{1}{2}$	..	..
	..	III.	544	98-141	43	115	119.5	114.4	4 $\frac{1}{2}$	A	26
	..	..	9	144-162	..	..	..	..	..	..	..
11th Nov. 1903	6-12	I.	48	13-25	12	19	19	18.6	2	A	2 $\frac{1}{2}$
	..	II.	90	79-109	30	95	94	94.3	3 $\frac{1}{2}$	..	..
	..	..	11	112-124	..	..	..	..	..	..	..

S=Spring.

A=Autumn.

Place and Date.	Depth.	Series.	Number.	Range in Size.	Difference.	Average Size.				Origin.	Probable Age.
						Modal.	Mean.	Arithmet.	Inches.		
Dornoch Firth—con. 12th Nov. 1903	Fms. 6-10	..	6	79-83	..	..	..	..	..	..	..
	..	III.	1228	84-133	49	105	108.5	105.4	4½	A	26
	..	..	15	134-152	..	..	..	..	..	..	..
	..	..	87	162-198	36	175	180	179.1	7	..	..
26th Dec. 1903	..	I.	51	14-34	20	19	24	22.3	¾	A	3½
25th Dec. 1900	12	III.	1769	98-144	46	119	121	122.4	4½	A	27
	..	IV.	172	145-178	33	..	161.5	..	..	A	39
	..	..	41	182-217	35	196	..	190.8	7½	..	..
<b>Burghead Bay.</b>											
29th Dec. 1903	5-12	I.	56	15-33	18	20	24	23.3	½	..	..
	..	III.	3	130-140	..	..	..	..	5½	..	..
25th Dec. 1901	7½-18	IV.	19	139-182	44	..	161	162.4	6½	A	39
	..	..	68	186-223	37	198	204.5	201	7½	A	51
28th Dec. 1903	5-13	II.	2	81-88	..	..	..	..	..	..	..
	..	..	12	97-127	..	..	112	113.3	4½	..	..
<b>Findhorn.</b>											
1st April 1904	..	IV.	11	123-169	46	..	143	150.8	5½	..	..
	30-32	V.	478	177-228	51	200	202.5	203.2	8	S	48½
	..	..	8	230-245	..	..	..	..	..	..	..
<b>Cromarty Firth.</b>											
10th Jan. 1901	..	III.	30	89-132	43	120	110.5	102.1	4	..	..
	..	..	3	140-149	..	..	..	..	..	..	..
1st June 1901	8	III.	1	104	..	..	..	..	..	..	..
	..	IV.	66	111-155	44	135	133	129.7	5½	A	33
	..	..	3	163, 174, 197	..	..	..	..	..	..	..
<b>Firth of Forth.</b>											
9th May 1901	7-11	II.	1	71	..	..	..	..	..	..	..
	..	III.	164	94-139	45	112	116.5	114	4½	S	26
	..	..	6	142-149, 187	..	..	..	..	..	S	..
10th May 1901	22	..	9	117-135	..	..	..	..	..	S	..
13th May 1901	7	III.	114	97-133	36	114	115	112.3	4½	S	26
<b>Combined</b>											
..	..	II.	1	71	..	..	..	..	..	S	..
	..	III.	277	94-139	45	113	116.5	113.7	4½	S	26
	..	..	6	142-149, 187	..	..	..	..	..	S	..

S=Spring.

A=Autumn.



Place and Date.	Depth.	Series.	Number.	Range in Size.	Difference.	Average Size.				Origin.	Probable Age.
						Modal.	Mean.	Arith-metic.	Inches.		
Firth of Forth—con.	Fms.			Mm.	Mm.	Mm.	Mm.	Mm.			Mths.
28th May 1901 .	7½	..	31	17-24	7	20	20.5	20.4	4½	S	2½
23rd July, 1901 .	..	..	8	109-137	28	..	123	125.4	4½	..	..
4th Sept. 1901 .	..	..	48	6-13	7	10	9	9.7	¾	A	..
(Isle of May.)											Years
16th Feb. 1904, ♀	..	VI.	215	225-250 (26.5)	25 (40)	244	237.5 (245)	239.9	9½	S	5
♂	..	VI.	256	218-250	32	237	234	236.7	9½	S	5
..	..	VI.	471	218-250	32	238	237.5	237.7	9½	S	5
.. ♀	..	VII.	248	251-281 (240)	30 (42)	257	266 (261)	262.1	10½	S	6
♂	..	VII.	282	251-281	30	257	266.0	261.0	10½	S	6
..	..	VII.	530	251-282	31	257	266	261.5	10½	..	6
.. ♀	..	..	10	283-305	22	..	..	..	..	..	..
♂	..	..	12	283-304	21	..	..	..	..	..	..
..	..	..	22	283-305	22	..	..	..	..	..	..
15th March, ..	..	VI.	256	211-244 (254)	33 (43)	235	227.5 (232.5)	232.8	9½	S	5
..	..	VI.	319	211-244	..	235	227.5	232.2	9½	S	5
..	..	VI.	575	211-244	33	235	227.5	232.5	9½	S	5
.. ♀	..	VII.	252	245-277 (235)	32 (42)	250	261 (256)	254.1	10	S	6
♂	..	VII.	317	245-277	32	250	261	252.7	10	S	6
..	..	..	569	245-277	32	250	261	253.5	10	S	6
.. ♀	..	VIII.	4	281-288	..	..	..	..	..	S	..
♂	..	..	5	278-304	..	..	..	..	..	S	..
.. ♀	..	..	2	324, 325	..	..	..	..	..	S	..

S=Spring.

A=Autumn.

The smaller groups in the collection are as follows, those from Aberdeen Bay being first considered :—

On 21st and 22nd August, 10 miles off Aberdeen, at the "Doghole," 22 small clupeoids were obtained in the tow-net, which may be referred to the autumn spawning. They measured from 8mm. to 11mm., the average being about  $\frac{5}{16}$  of an inch.

About a month later, on 18th and 20th September, 194 were taken in shallow water (up to 3 fathoms) in Aberdeen Bay. They measured from 21mm. to 44mm. ( $\frac{1}{3}$ – $1\frac{3}{4}$  inches), the size of greatest frequency (modal size) being 33mm., or  $1\frac{5}{16}$  of an inch, and the arithmetic average

34.3mm. They were thus about 24–25mm., or 1 inch, longer than the group in August, and clearly belonged to another and earlier spawning, that is, to the spring series.

Two of them, however, which measured 21mm., might possibly belong to the autumn herrings. The numbers in 2-millimetre grouping are these :—

20-1	22-3	24-5	26-7	28-9	30-1	32-3	34-5	36-7	38-9	40-1	42-3	44-5
2	1	8	6	15	19	30	33	25	24	20	10	1

These young herrings would thus be about 5–6 months old.

The autumn herrings are well represented in some collections procured later in the year. Thus, on 2nd October, 297 measured from 9mm. to 20mm., the average size being about 15mm. On 3rd October, 334, also taken in Aberdeen Bay, measured from 8mm. to 27mm. ( $1\frac{5}{8}$ – $1\frac{1}{8}$  inches), the size of greatest frequency being 17mm., the average 16.2mm., and the mean size 17.5mm. ( $1\frac{1}{4}$  of an inch). Two of these herrings, again, probably belong to the spring series, measuring respectively 26mm. and 27mm. The sizes, arranged in 2-millimetre groups, are these :—

11-12	13-14	15-16	17-18	19-20	21-22	23-24	25-26	27-28
28	54	85	107	47	10	—	1	1

The age of these may be estimated at from one to two months.

The same group is again well represented about a month later, when 181 were taken on 6th November, but in a different year. They measured from 12mm. to 25mm. ( $\frac{1}{2}$ –1 inch)—the maximum size rather supporting the suggestion made above, that the two at 26mm. and 27mm. in the October collection belonged to the spring group—and the modal size or mean was about 18mm., the average size being 18.3mm. ( $\frac{3}{4}$  inch). The arrangement, in 2-millimetre grouping, is as follows :—

12-13	14-15	16-17	18-19	20-21	22-23	24-25
6	17	42	57	40	15	4

On the 23rd December six herrings were taken, whose measurements were as follows :—23mm., 24mm., 25mm., and 32mm., 33mm., 36mm. (from  $1\frac{1}{4}$ – $1\frac{1}{8}$  inches), and they possibly belonged to two series.

On the 12th of the same month, and in the same year, another collection in Aberdeen Bay numbered 15, their sizes ranging from 42mm. to 50mm. ( $1\frac{1}{4}$ –2 inches), the size of greatest frequency being 45mm., while the mean was 46mm., and the average 46.5mm., or nearly  $1\frac{1}{2}$  inches.

These probably represent the spring herrings, whose average size in the September collection was 33mm., the growth over the twelve weeks amounting to about 14–15mm. ( $\frac{5}{8}$  inch).

The sizes and increments of these post-larval autumn herrings may be thus summed up :—

Date.	Size.		Increase	Days.
	Range.	Average.		
21st, 22nd August,	Mm. 8-11	Mm. 9.0	Mm. —	—
2nd October, - -	9-20	15.0	6	42
3rd October, - -	8-22	17	8	43
6th November, -	12-25	18	9	77

The next collection of small herrings from Aberdeen Bay was on 24th April, in another year. They numbered 157, and ranged in size from 41-46mm. ( $1\frac{5}{8}$ - $1\frac{1}{2}$  inches)—the modal size, the mean size (calculated on the base-line of the curve) and the arithmetical average, all agreeing at 43.5mm., or  $1\frac{3}{4}$  inches.

These herrings are clearly not those from the previous spring series, but from the preceding autumn, and they are approximately seven or eight months old.

Small herrings were also obtained in June in Aberdeen Bay in two separate years. In 1900 a shoal appeared in the Bay of Nigg, apparently driven in by coal-fish (of which a large number were got in the salmon stake-nets); fifteen of these, taken on the 19th, were measured by Dr. Scott, who determined the contents of the stomach.\* They ranged between 5.5cm. and 6.5cm. ( $2\frac{1}{8}$ - $2\frac{3}{8}$  inches), the mean length being about 60mm., or  $2\frac{3}{8}$  inches; but it is, of course, quite uncertain if they were representative of the shoal.

Two of the herrings belonging to the shoal were placed by me in a large glass carboy, containing about 18 gallons of water, and a circulation maintained. These herrings were not attempted to be measured until 15th August, when one was found to be approximately 73mm. ( $2\frac{7}{8}$  inches) and the other 83mm. ( $3\frac{1}{4}$  inches); they were placed in a narrow tube full of sea-water while being measured. On the 28th September another attempt was made to measure them, and one was found to be 83mm. ( $3\frac{1}{4}$  inches); but it showed such signs of collapse that I refrained from measuring the other herring, and both of them were lost some time afterwards.

If their size was about 60mm. on the 19th June, the indicated growth in the two months would be approximately 13-23mm. ( $\frac{1}{2}$ - $1\frac{1}{8}$  inch), and the growth of one of them, assuming it to be the smaller measured in August, from the latter period to 28th September would amount to 10mm. for the 44 days. These data are obviously slender and uncertain. At all events, the remark was a common one at the time, that the herrings were growing very slowly.†

In June of another year a series was represented by 24 specimens, measuring from 50mm. to 60mm. ( $2$ - $2\frac{3}{8}$  inches), the modal size being 55mm., and the arithmetic average 55.8mm. ( $2\frac{1}{8}$  inches).

On 18th October, in a large collection, there was one measuring 85mm. ( $3\frac{3}{8}$  inches), the next, part of a large group, measuring 96mm. The former was certainly in its second year.

Turning now to the collections of small herrings from other parts of the coast, we find corresponding series.

In the Dornoch Firth, on 21st October, 28 post-larval herrings were taken in a tow-net. They measured from 14mm. to 20mm., the modal size and the mean being 17mm., and the arithmetical average 16.8mm. ( $1\frac{1}{8}$  inch). These were from the autumn spawning.

On 11th November, 48 were caught in a tow-net, which ranged in size from 13mm. to 25mm., the mode and the mean being 19mm., and the arithmetical average 18.6mm. ( $\frac{3}{4}$  inch). On 13th November, in the same year, 156 were caught in tow-nets, measuring from 13mm. to 26mm. ( $\frac{1}{2}$  to slightly over 1 inch); the modal size was 20mm., the mean 19.4mm., and the average 19.5mm. ( $\frac{3}{4}$  inch). On 26th December, in the same year, the series is, perhaps, represented by 51 specimens, measuring

\* See *Twentieth Annual Report*, Part III., p. 530.

† A small rockling kept in the same vessel, lurking among stones and weed at the bottom, offered a striking contrast to the herrings. On 15th August it measured 57mm., on 28th September 89mm., and on 14th November 97mm. It was fed with mussels. On the other hand, the growth of the common pipe-fish (*Syngnathus acus*) was very slow.

from 14mm. to 34mm. ( $1\frac{1}{8}$ – $1\frac{3}{8}$  inches), the modal size, or size of greatest frequency, being 19mm., the mean 24mm., and the average 23·3mm., or  $\frac{7}{8}$  of an inch.

The collection seems to include more than members of one series, however, the numbers under each millimetre being as follows:—

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	2	5	3	5	3	3	2	3	5	4	1	1	3	2	2	2	2	2	—	1

The growth is thus very slow, the increments being as follow:—

Date.	Size.		Increase.	Days.
	Range.	Average.		
21st October, ... ..	Mm. 14–20	Mm. 17	Mm. —	—
11th November, ... ..	13–25	19	2	21
15th November, ... ..	13–26	19·5	2·5	25
26th December, ... ..	14–34 ? [14–26 ?]	22·3 ? 20	5·3 ? 3·0	66 66]

The sizes, it will be seen, agree very well with the post-larval herrings from Aberdeen Bay at corresponding periods.

For the reason stated, it is probable that the average, and therefore the amount of growth in the December series, is too large.

Near Burghhead Bay, on 29th December, 1903, 56 post-larval clupeoids, measuring from 15mm. to 33mm., were taken, the modal size being 20mm., the mean 24mm., and the arithmetical average 23·3mm. ( $1\frac{1}{8}$  inch). The arrangement of the measurements under the various millimetres is as follows:—

15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1	2	2	6	5	5	1	6	2	3	4	3	2	3	1	5	1	3	1

There are some reasons to suspect that these clupeoids may be sprats; the diagnosis is therefore uncertain.

On May 28, a compact series, numbering 31 specimens, and measuring from 17mm. to 24mm. were taken in the Firth of Forth. The modal size was 20mm., the mean was 20·5mm., and the average 20·4mm., or  $1\frac{1}{8}$  of an inch. These represent the spring herrings, approximately two months old.

The autumn herrings are represented by a collection taken at the mouth of the Forth on 4th September, in the same year. There were 48, measuring from 6mm. to 13mm., the modal size being 10mm., the mean 9mm., and the average 9·7mm., or  $\frac{3}{4}$  of an inch. The arrangement of the measurements of these two collections in millimetres is as follows:—

	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
(1)	—	—	—	—	—	—	—	—	—	—	—	1	4	2	10	7	3	2	2
(2)	3	—	1	16	17	7	3	1	—	—	—	—	—	—	—	—	—	—	—

In the Forth collections, the next older series is represented by one herring, 71mm. ( $2\frac{1}{8}$  inches) long, taken on 9th May, and by one of 85mm., caught on 19th June.

In some collections from the Firth of Clyde, the series is well indicated. Thus, on 17th October, the shrimp-trawl, working in from

37 to 53 fathoms, took 91, measuring from  $2\frac{1}{4}$  to  $3\frac{1}{4}$  inches (57mm. to 82mm.), most measuring from  $2\frac{1}{4}$  to  $2\frac{3}{4}$  inches (63mm. to 70mm). The measurements were carefully made to fractions of an inch, as follows:—

$\frac{2\frac{1}{4}}{6}$	$\frac{2\frac{1}{2}}{35}$	$\frac{2\frac{3}{4}}{35}$	$\frac{3}{12}$	$\frac{3\frac{1}{4}}{3}$	$\frac{3\frac{1}{2}}{-}$
--------------------------	---------------------------	---------------------------	----------------	--------------------------	--------------------------

One at  $2\frac{3}{4}$  inches (70mm.) was caught in the same neighbourhood on the same day, and another of 70mm. at the mouth of the Clyde on 23rd November, while in December, on the 17th and 18th, 20 were taken in Lochfyne, measuring from 5·5cm. to 9cm., as follows:—

$\frac{5\cdot5}{2}$	$\frac{6}{4}$	$\frac{6\cdot5}{4}$	$\frac{7}{5}$	$\frac{7\cdot5}{3}$	$\frac{8}{1}$	$\frac{8\cdot5}{-}$	$\frac{9}{1}$
---------------------	---------------	---------------------	---------------	---------------------	---------------	---------------------	---------------

Some of the herrings taken in the Firth of Forth in previous years by the *Garland*, which are included in the Table at the end of the paper (III.), and shown on Plate XIX. by dotted lines, belong to the same series. They were measured by Dr. T. Scott in fractions of an inch, and grouped together, and thus in some cases it is not easy to separate them into groups. In some instances, however, the distinction is easy. They were all taken in a fine-meshed shrimp trawl net.

The number of hauls made was 135, apportioned to the various months as follows—the depths are in fathoms:—

	1889.		1890.		1891.		1892.	
	No.	Depths.	No.	Depths.	No.	Depths.	No.	Depths.
February, -	-	-	6	6-27	-	-	2	3-5
March, -	-	-	10	3-28	-	-	-	-
April, -	-	-	10	4-24	-	-	5	6-14
May, -	26	3 $\frac{1}{2}$ -31	9	5-24	-	-	-	-
June, -	14	4-24	-	-	-	-	-	-
August, -	-	-	-	-	3	5-12	-	-
September, -	33	4-29	-	-	-	-	-	-
October, -	11	5-28	-	-	-	-	-	-
December, -	-	-	-	-	-	-	6	8-27

The particulars in regard to the herrings taken are given in the following Table, the ordinary figures referring to the length in inches, and those in brackets to the corresponding length in millimetres:—

Date.	Depth.	Herrings.
	Fms.	
21st February 1890 .	24-27	1 at 4 (100).
17th " " .	6½-9	12, 3½-5 (90-127).
20th " " .	11-14	3, 4½-5 (115-127); 2, 3 (76).
6th " " 1892 .	5	240, 1½-3½ (45-69).
19th March 1890 .	20-27	21, 4-5½ (102-140).
19th " " .	18-28	2, 4½-5½ (115-140).
21st " " .	9½-14	29, 4-5 (102-127); 2, 3½ (89).
21st " " .	4½	1, 4 (102).
22nd " " .	5-6	5, 4½-5½ (115-140); 158, 2½-3½ (63-89).
22nd " " .	4-6	11, 4½-5½ (115-133); 169, 2½-3½ (63-89).
22nd " " .	3-4	16, 4-4½ (102-115); 14, 3-3½ (76-89).
20th April 1892 .	7-8	316, 1½-3½ (45-82).
28th " " 1890 .	4	767, 2-3½ (50-90); 1, 5½ (140).
28th " " .	18-20	6, 4-5 (102-127).
29th " " .	17	1, 5½ (140); 8, 5 (127); 15, 2½-4 (70-102).
29th " " .	6-15	37, 6 (150); 219, 3½-4 (90-102); 786, 1½-3 (45-76).
29th " " .	8-10	6, 3-3½ (76-89).
9th May 1889 .	4	1, 7 (177); 124, 4-5 (102-127); 7, 3 (76); 24, 2½ (63); 30, 2 (50).
10th " " .	6	1, 3 (76).
11th " " .	11-12	1, 7 (177); 1, 6½ (165); 3, 4½ (108).
14th " " .	15	1, 4½ (115).
15th " " .	5	3, 2½ (63).
7th " " 1890 .	9	6, 4½ (115).
8th " " .	5-9	2, 4 (102).
9th " " .	20	1, 5 (127).
5th August 1891 .	6	3, 3½ (95).
3rd September 1889 .	5	118, 2½-3½ (63-89).
4th " " .	15	1, 3 (76).
4th " " .	29	2, 3 (76).
5th " " .	5	14, 2-2½ (50-63).
5th " " .	6	2294, 2½-3½ (63-89).
12th " " .	26	1, 3 (76).
13th " " .	22	1, 3 (76); 1, 2 (50).
5th October 1889 .	5	8, 3 (76).
10th " " .	5	2, 4½ (115); 4, 3½ (89); 9, 3 (76).
10th " " .	12	22, 4-4½ (102-115).
16th " " .	12	2, 3½ (89).
9th December 1892 .	13-15	6, 3½-4 (89-102).
10th " " .	11-14	3, 4½-5 (115-127).

At least three annual series of herrings are represented in these Forth collections. From what has been said above as to the slow growth of the post-larval herring, it is clear that none of them belong to the year in which they were caught, but that the smallest of them are in their second year.

The measurements in fractions of an inch, and the slumping of lots together, are less accurate than the separate measurements in millimetres, and two separate series may be mixed up together, but it appears, on the whole, probable that the smaller herrings in spring represent the spring herrings and not the autumn fish. In February, March, and April their sizes range from about 45mm. to about 89mm. or 90mm.; the smaller sizes would suit well enough the supposition that they were autumn herrings, but the larger are much too large for that class at that time of year, and if they are all regarded as belonging to one group, the group must be looked upon as spring fish nearing one year of age, though the larger sizes are too large for this interpretation. This must be said, on the balance of evidence, even regarding the large

collection on 29th April and the collection on 9th May, measuring in the former from 45mm. to 76mm. approximately, and in the latter from 50mm. to 76mm.; but what has been said as to the method of measurement and recording must be borne in mind.

On the other hand, it appears probable that the bulk of those obtained in September, measuring from 50mm. and 63mm., are autumn herrings of the year before, and thus about one year of age. The important point established, however, is that all these small herrings are in their second year and are not derived from the spawning of the same year.

The next group, extending from about 90mm. to 127mm. or 130mm., are one year older, that is to say, they are in their third year. It is possible that in spring they may go as high as 140mm. ( $5\frac{1}{2}$  inches), a limit included in the above Table, but it is not probable, judging from the other collections, although in autumn the size would be in accordance with the collections referred to.

It will be noticed that none of these small herrings were taken in the shrimp-trawl in the latter part of May, or in June. It is not unlikely that they leave the bottom for the most part in the early part of May. I may add that no herrings were obtained in fifteen hauls of the same net in the Moray Firth in June and July.

A few small herrings were also obtained from the shrimp-nets used in the Solway Firth. On 30th July, nine were got, seven measuring from 60mm. to 75mm., one 83mm., and one 90mm. The average for the nine fish, if taken together, is 72.9mm., or  $2\frac{7}{8}$  inches. On 28th September three were taken, which measured 60mm., 72mm., and 78mm., the average being 70mm. ( $2\frac{3}{4}$  inches); on 31st October, three taken measured 50mm., 64mm., and 81mm., the average being 65mm., or a little over  $2\frac{1}{2}$  inches.

A summary of the range of sizes of the herrings, both of the spring and of the autumn series, is given in the following Table, arranged according to the data furnished by Masterman (M.) and also by the collections of the Fishery Board (F. B.).

[TABLE.]

	Spring.		Autumn.	
	M.	F. B.	M.	F. B.
	Mm.	Mm.	Mm.	Mm.
February, . .	..	..	..	..
March, . . .	5-11	7-11\	..	..
April, . . .	5-16	6-17	..	..
May, . . . .	5-25	7-5-24	..	..
June, . . . .	13-20	15-26	..	..
July, . . . .	16-37	16.	..	..
August, . . .	[11-20]	..	5-12	6-14
September, .	36-44	21-44	4-18	6-18
October, . . .	32-41	32	6-23	8-25
November, . .	..	..	14-26	12-29
December, . .	[37]	39-50	15-[37]	14-34, 36
January, . . .	42-56	..	..	27
February, . . .	41	45-69	35-37	31, 32
March, . . . .	44	(63)-(89)	26-40	..
April, . . . .	..	(45)-(82)	32-49	41-46
May, . . . . .	..	71	..	50-63

In the *Fourth Annual Report of the Fishery Board for Scotland* Mr. Duncan Matthews described the young herrings found in various samples of whitebait from the Thames. His results may be thus summarised, the words in brackets indicating my interpretation of the derivation of the herrings, which thus differs from that of Cunningham, who dealt with the same observations of Matthews (18, p. 162).

Month.	Number Herrings Examined.	Remarks.
February, . .	98	Some under 2 inches (50mm.) and only partially scaled (probably spring-herrings of previous year).
March, . . .	60	Some reached nearly 4 inches (102mm.) (autumn herrings in third year).
April, . . .	112	14 under 1½ inches (38mm.) (autumn herrings of previous year).
May, . . . .	180	72 were 2 inches (50mm.) fully scaled (autumn herring) and 108 from 1½-1¾ inches (38mm.-44mm.) and only partly scaled (autumn herrings).
June, . . . .	696	417 fully scaled, 2-2½ inches (50mm.-57mm.) (autumn), 279, from 1 to 1½ inches (25mm.-38mm.) partially scaled, or entirely scaleless (spring herrings of year, but possibly two series).
July, . . . .	450	1½-2½ inches (38mm.-63mm.), of these, 360 under 2 inches (50mm.) (probably two series—spring and autumn).
August, . . .	260	2-3 inches (50mm.-76mm.) (autumn).

The usual difficulties involved in measurements in fractions of an inch, and slumping, is encountered here, though in most cases the derivation of the series seems clear. To suppose that herrings of 63 or 55mm. in July, were derived from the spawning in the previous spring would be contrary to the facts referring to the Scottish collections. The spawning-seasons may differ to some extent off the mouth of the Thames.

The observations of Hoek on the small herring in the Zuiderzee (14), previously referred to, would be valuable for comparison, but it is clear that different series have been included together in some of the groups. A summary of his measurements, in millimetres, is as follows:—February, 73-100, most between 83 and 95: March, 49-75, 70-78, 83-114, 77-100, most between 85-95, 67-106: April, 67-102, "most part about 80"; a few days later, "most of them 75," a few about 90: May, many about 90, four 55: June (29th), a few 37: July, 37-42, 57-60, 75, 80, 98: August, 56-81, 60-68, and on 31st, 40-50, 60-70: September, 58-75, 76-83, 65-95: October, 81-90, 65-80: November, one 75, many 85-90, 100-112.5: December, many 80-100.



(b) *The Annual Groups.*

In dealing with the numerous collections of larger herrings, it will not be necessary to refer to them all in detail. The method I adopted in elucidating the rate of growth and the age of the herrings in the various collections was as follows. After determining the rate of growth and the sizes for the first and second year, I set down on a very large and long sheet, divided into centimetre and millimetre squares, all the other collections, showing the range of sizes and the average or modal size, that is, the size at and around which the great bulk of the herrings in a collection were aggregated. Very little consideration was required to allot almost all the collections in a particular month to the proper year, and in the accompanying Table I have represented the modal sizes of the collections in this manner, and also in some cases (by a cross) the sizes of individual herrings or small collections.

There are a few general considerations that may be referred to. The collections were in nearly every case made by means of a small-meshed net fixed outside the cod-end of an ordinary large otter trawl, which was dragged along the bottom for an hour and more. Several miles of bottom were thus trawled over, and this is probably the explanation that a mixture of herrings of different series occurs in a few of the collections. In most instances this has not happened, the groups being very distinct; but in some there are a few, or many, herrings either larger or smaller than the limits of the series, and in one or two collections the spring and autumn series seem to be more or less blended. They are referred to below.

The larger fully adult herrings are not well represented in the collections, probably from their more pelagic habitat. The small herrings in their second year are also not very fully represented until the winter, doubtless due to the fact that they were able to escape through the meshes of the net. They are well shown, however, in the collections made in the Firth of Forth by the *Garland*, with a fine-meshed shrimp-trawl, and also in Lochfyne, as above described.

In May certain collections of small herrings were obtained in the Firth of Forth with the small-meshed net around the otter-trawl. On the 9th, in from 7 to 11 fathoms, 161 were taken. The smallest was a single herring measuring 71mm. ( $2\frac{1}{8}$  inches), representing the herrings in their second summer, and about one year old, more or less. The next measured 94mm. ( $3\frac{1}{8}$  inches), and was the smallest of a group of 154 herrings, apparently the largest of which measured 139mm. ( $5\frac{1}{2}$  inches). The modal size was 112mm. ( $4\frac{1}{8}$  inches), the mean 116.5mm., and the arithmetic average 114mm. ( $4\frac{1}{2}$  inches). There were other four herrings, from 142mm. to 149mm., and a single one at 187mm. The four referred to might belong to the group; but the indications of other series are against this view; the series might, on the other hand, so far as the millimetre table indicates, have stopped at 130mm. or 133mm. In either case, the modal size is unaffected, and the average but slightly.

On the 10th May, twelve herrings were taken, nine of which were from 117mm. to 135mm. in length, and three from 140mm. to 153mm.

On the 13th, the collection contained 114 herrings, forming a compact series from 97mm. to 126mm., there being another at 133mm., which is taken as the end of the group. The modal size was 114mm. ( $4\frac{1}{2}$  inches), the mean 115mm., and the arithmetic average 112.3mm.

If the herrings in this group in the three collections are combined, the number is 277, the apparent range of sizes from 94mm. to 139mm. ( $3\frac{1}{8}$  to  $5\frac{1}{8}$  inches), the modal size 113mm., the mean 116.5mm., and the average 113.7mm. ( $4\frac{1}{2}$  inches).



16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Cm.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January. February. March. April. May. June. July. August. September. October. November. December.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January. February. March. April. May. June. July. August. September. October. November. December.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January. February. March. April. May. June. July. August. September. October. November. December.
x 1 1	x	..	..	..	..	..	..	..	..	..	..	..	..	..	January. February. March. April. May. June. July. August. September. October. November. December.
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	January. February. March. April. May. June. July. August. September. October. November. December.
xx	xx	xx	..	1 .. x	..	..	..	..	..	..	..	..	..	..	January. February. March. April. May. June. July. August. September. October. November. December.
..	..	..	..	..	..	..	1 xxx xx	.. xxx xx	..	..	..	..	..	..	January. February. March. April. May. June. July. August. September. October. November. December.
..	..	..	..	..	..	..	..	1 1	..	..	..	..	..	..	January. February. March.
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Cm.

These herrings, as the other collections and measurements show, are in their third summer, and are spring herrings a little over two years of age.

To this series also belong nine herrings taken by the *Garland* on 16th May, measuring from about 9cm. to 12cm.

In July in the same year a small collection of herrings was secured. There were only eight of them, ranging in size from 109mm. to 137mm., the mean being 123mm. and the average 125.4mm. ( $4\frac{1}{4}$  inches).

In Aberdeen Bay some large collections of herrings at a corresponding stage were obtained. On October 18th they numbered 444. There was one at 85mm. ( $3\frac{3}{8}$  inches), the next being 96mm., and the group to which the latter belonged extended to about 141mm. It contained 429 herrings, the modal size of which was 115mm., the mean was also 115mm. ( $4\frac{1}{2}$  inches), and the average was 117.5mm., or  $4\frac{7}{8}$  inches. These herrings were thus of almost the exact size of the group caught in the Forth in May, and may be referred to the autumn series, somewhat over two years old. The group might terminate at a slightly smaller size than that indicated, *e.g.*, 137mm.; on the other hand, there were five herrings measuring 143mm. to 145mm., three from 151mm. to 154mm., and one at 164mm. It is possible that the first five belong to the group, but the balance of evidence is against the supposition; in any case, the mode and average would not be appreciably affected. All the herrings referred to probably belong to a group, extending in this case from 143mm. to 187mm.

Another large collection obtained on 31st October, but in the previous year, was made up of younger herrings. The curve of the measurements (see Plate XVII.) is slightly irregular, there being a small depression at about 7.5cm., and two slight cusps at 7cm. and 8cm. Consideration of other cases shows that the group extends to about 9.5cm., and is really one. The 650 herrings contained in it extend from 52mm. to about 95mm. ( $2\frac{1}{8}$  to  $3\frac{3}{8}$  inches); the chief mode is at 8cm. ( $3\frac{1}{8}$  inches), the mean at 73mm. ( $2\frac{7}{8}$  inches), and the average at 77.8mm., or  $3\frac{1}{8}$  inches. These herrings are obviously those of the year before, and autumn herrings, so that they would be about 13 to 15 months old. The difference between this group and the group of the 18th (in the following year), both of which are supposed to be autumn herrings, is, on the modes 35mm., on the means 42mm., and on the averages as computed 39.7mm., the mean of the three being 38.9mm. ( $1\frac{5}{8}$  inches). The mode, as we have seen, is not regular in the collection of 31st, and is better at 7.5cm., which would make the difference 40mm. and the mean of the three comparisons 40.6mm., or  $1\frac{5}{8}$  inches, representing a year's growth.

The next group consisted of 179 herrings from about 96mm. to 143mm., but the larger individuals are not well represented. They appear to belong to the corresponding group so well shown in the collection of 18th October. There was a single herring at 157mm.

On November 6th and 9th, in three different years (1900, 1901, 1903) small collections were obtained, which may be combined and summarised. Seven measured from 75mm. to 100mm., the computed average being 87.7mm. ( $3\frac{3}{8}$  inches); 48 ranged from 102mm. to 143mm. ( $4$  to  $5\frac{5}{8}$  inches), the computed average being 125mm. ( $4\frac{1}{4}$  inches). There were also two herrings 185mm. and 188mm.

On 12th December, six herrings measured from 97mm. to 124mm. ( $3\frac{1}{4}$  to  $4\frac{7}{8}$  inches), the mean size being 110.5mm. and the average 109.3mm.

On 19th December, six, measuring from 78mm. to 95mm. were caught, the average size being 90.5mm., or  $3\frac{5}{8}$  inches; there were also five ranging from 110mm. to 131mm., the average being 120mm., or  $4\frac{3}{4}$  inches.

On the 18th December, a collection of 410 herrings varied in size from 110mm. to 165mm. ( $4\frac{1}{4}$  to  $6\frac{1}{2}$  inches), the range being thus 56mm. The mean was 137mm., the average 137.5mm., and the mode 141mm. (a little over  $5\frac{1}{2}$  inches). An examination of the millimetre table, or of the curve (Pl. XVII.) shows that there is in this case a slight fusion of two groups, and that the beginning of the large group is probably about 11.5cm. The 2-millimetre arrangement of the measurements is as follows—

109-110	111-2	113-4	115-6	117-8	119-20	121-2	123-4
1	3	1	3	5	8	9	17

At the end of the series the 2-millimetre arrangement is this :—

150-1	152-3	154-5	156-7	158-9	160-1	162-3	164-5
11	12	3	4	3	4	-	1

the mode being 141mm., the mean 137.5mm., and the computed average 135.9mm. The mode ( $5\frac{9}{8}$  inches) probably best represents the group. These herrings are spring herrings about 2 years and 8 or 9 months old ; those taken on the 17th appear to be the autumn series, about 2 years and 3 or 4 months old. On the 29th December, 16 herrings were taken, from 108mm. to 154mm.

A series of older herrings than these were caught in Aberdeen Bay in May and June, 1901 and 1903.

On the 30th May, 1901, the collection numbered 601, ranging from 142mm. to 228mm., and forming two series at least. The first contained 598 herrings, from 142mm. to 186mm. ( $5\frac{7}{8}$  to  $7\frac{3}{8}$  inches), or it might be 182mm. The modal size was 159mm. or 160mm., the mean 164mm., and the computed average 162mm., or  $6\frac{3}{8}$  inches. These herrings are in their fourth year, and, judging from their position in relation to other series on the synthetic table, they are spring herrings, and thus a little over three years old.

There were other three herrings, measuring respectively 196mm., 207mm., and 228mm. (9 inches).

Two collections were obtained in June. The first, on the 13th (1903), contained 557 herrings, and three series were present. The curve (Pl. XVII.) and the millimetre table show that the first great group is not pure, but is slightly mixed with the next group of larger herrings, represented on 30th May and on 28th June, and the measurements extend from 118mm. to 182mm., a range of 64mm., which is too large. The first series begins at 118mm., and apparently extends to 163mm. ( $4\frac{4}{5}$  to 6 inches), but it might go to 167mm. The 2mm. arrangement of the measurements at this part is as follows :—

156-7	158-9	160-1	162-3	164-5	166-7	168-9	170-1
19	17	13	6	9	4	6	5

The modal size of the group is 138mm. or 139mm. ( $5\frac{1}{2}$  inches), the mean is 140.5mm., and the computed average 141.8mm., or  $5\frac{5}{8}$  inches. This group is thus about 2cm. ( $\frac{3}{4}$  inch) less than the group on 30th May, and I take it to represent autumn herrings in the fourth year, that is, which want about three months of being three years old. The group of 405 spring herrings, taken in Aberdeen Bay on 18th December, above referred to, were of about the same age (2 years and 9 months) and of the same size as these.

The spring herrings mixed with them number about 30, and range from about 164mm. to 182mm. There were also four herrings measuring 208mm., 223mm., 225mm., 234mm.

On the 28th June, fifteen days later, but in 1901, 650 herrings were taken at Lunan Bay, a little further down the coast, in  $12\frac{1}{2}$  fathoms.

They formed a compact group (Pl. XVII.) ranging from 148mm. to 192mm.  $5\frac{1}{8}$  to  $7\frac{9}{16}$  inches), the modal size was 167mm. ( $6\frac{9}{16}$  inches), the mean was 170mm., and the computed average 168.8mm., or  $6\frac{11}{16}$  inches. These herrings were obviously the same series as those taken on 30th May, that is, herrings in the fourth year, and thus, in all probability, spring herrings somewhat over three years of age.

The increment of length in the 29 days is, on comparison of the modes, 7mm. to 8mm., on the means 6mm., and on the averages 6.9mm., or a little over  $\frac{1}{4}$  inch. The rate per day, taking the increase at 7mm., was 0.241mm., and per month about 7.5mm., and this in the best period for growth. If a similar rate is assumed for July and August, the increase in the three best months of the year would amount to a little over 22mm. ( $\frac{7}{8}$  inch), which contrasts with the growth of the whiting, as indicated on a former page.

If the group taken on 13th June is contrasted with the small herrings got in the Bay of Nigg, Aberdeen, on the 19th June, referred to previously, whose average was about 60mm., and which were also judged to be autumn herrings, the growth in the two years is seen to amount to about 80mm. ( $3\frac{3}{8}$  inches). If, moreover, the herrings taken in Aberdeen Bay on 30th May are contrasted with those taken at the beginning of the same month (and year) in the Firth of Forth (both being judged to be spring herrings, and the latter about thirteen months younger), the differences are as follows:—On the modes 46mm., on the means 47.5mm., and on the computed averages 48.5mm., showing a mean difference of about 47mm. ( $1\frac{7}{8}$  inches), or at the rate for the whole period of 385 days of about .122mm. per day, or 3.7mm. per month. On 5th July, 1901, eight herrings were taken in Aberdeen Bay, measuring from 140mm. to 164mm. The modal size was 140mm., the mean 150mm., and the computed average was 149.2mm., or  $5\frac{1}{4}$  inches. They belonged, no doubt, to the same series as that of 13th June.

Some good collections of herrings were obtained in the Dornoch Firth. On 9th February 8 ranged from 104mm. to 122mm., the mode and the mean were 113mm., and the average was 112.4mm., or  $4\frac{3}{8}$  inches. The position of these is in February of the third year, *i.e.*, nearly two years old, if spring herrings, as they probably are.

Sixteen obtained on 31st March ranged from 106mm. to 136mm. ( $4\frac{3}{8}$  to  $5\frac{3}{8}$  inches), the mode being 112mm., the mean 121mm., and the computed average 117.6mm., or  $4\frac{5}{8}$  inches. No doubt they represent the same series as in February, and are about two years of age.

Several collections were obtained in November. On 5th November, 1900, in from 7 to 10 fathoms, 4784 herrings were taken in a haul of  $1\frac{1}{2}$  hours' duration, of which 601 were measured. The smallest noted was 73mm., and the largest 206mm., and the great majority ranged about 11cm. to 11.5cm. The first series is not fully represented, probably because of the escape from the net of the smaller fishes. It extended from 73mm. to about 97mm.; it might be 99mm.; the mean was 85mm., and the computed average 90mm., but the herrings represent only part of a series (in their second year). The 2mm. arrangement of the measurements at this place is as follows:—

86-7	88-9	90-1	92-3	94-5	96-7	98-9	100-1	102-3	104-5	106-7	108-9
5	7	7	9	8	3	5	7	6	17	19	36

The next series is taken as extending from 98mm. to 141mm. ( $3\frac{7}{8}$  to  $5\frac{9}{16}$  inches), but it may end about 13cm. or 13.5cm. The arrangement of the 2mm. measurements is as follows:—

124-5	126-7	128-9	130-1	132-3	134-5	136-7	138-9	140-1	142-3	144-5
21	16	8	2	4	3	1	2	1	-	2

This series comprised 544 herrings, the mode was 115mm., the mean 119.5mm., and the computed or arithmetical average 114.4mm. ( $4\frac{1}{4}$  inches). These were probably autumn herrings over two years of age. There were also 9 herrings from 144mm. to 162mm.

On the 11th November, 1903, in from 6 to 12 fathoms, 110 herrings were caught. Of these 99 ranged from 79mm. to 109mm., the mode was 95mm., the mean 94mm., and the average 94.3mm., or  $3\frac{3}{4}$  inches.

On the following day (12th) 1336 herrings were taken in from 6 to 10 fathoms, and all measured. The first series, comprising 1234 herrings, apparently ranged in length from 79mm. to 133mm. ( $3\frac{3}{8}$  to  $5\frac{1}{4}$  inches); the series might, however, terminate about 133mm. or 136mm. or 138mm. The above range (54mm.) is greater than usual. On the other hand, the series might not begin till about 83mm. or 85mm. There is not uncommonly a difficulty in assigning the position of the odd fish at the beginning or end of a series, which may belong to different groups, but the influence on the average size is quite unappreciable, while the mode is unaffected. The 2mm. arrangement at the beginning of the series on 11th and 12th November is as follows:—

	79-80	81-2	83-4	85-6	87-8	89-90
11th . .	1	—	5	9	9	9
12th . .	2	2	3	9	15	22

The most appropriate interpretation is that the series begins at 84mm. and extends to 133mm. ( $3\frac{3}{8}$  to  $5\frac{1}{4}$  inches). The modal size is 105mm., the mean 108.5mm., and the average 105.4mm., or  $4\frac{1}{8}$  inches. These herrings are doubtless autumn herrings, two years and a few months old.

Most of the remaining herrings in the collection, viz., 87., measured from 161mm. to 198mm. ( $6\frac{3}{8}$  to  $7\frac{1}{2}$  inches), the mode being 175mm., the mean 180mm., and the computed average 179.1mm., or a trifle over 7 inches. The group is only partially represented, but as the difference from the other and younger group amounts to over 70mm., it is evident that they do not represent that series when one year older. They are apparently spring herrings, about three years and seven months old, members of the group present in the collection from the Dornoch Firth on 15th December, and in that taken at Burghead Bay in December, referred to below.

The herrings between 133mm. and 162mm. numbered 15, from 134mm. to 152mm., and they belong to another group, viz., that shown in the December collection from Aberdeen Bay.

A large number of herrings were taken on 25th December in the Dornoch Firth in another year. The youngest series comprised 1769 fishes, measuring from 98mm. to about 144mm. ( $3\frac{7}{8}$  to  $5\frac{1}{4}$  inches); the modal size was 119mm. ( $4\frac{1}{8}$  inches), the mean was 121mm., and the computed average 122.4mm. ( $4\frac{1}{8}$  inches).

These are autumn herrings, two years and some months old. The size of the corresponding group taken on 12th November, and described above, was 105mm., while here, 43 days later, it is above 14mm. higher. The amount is too much to be accounted for by increment of growth in the interval; and the explanation is probably to be found in the fact that the collections belong to different years (1900 and 1903) there being, doubtless, as with other fishes, a variation in the growth in different years.

Only a few belong to the second series (represented in Aberdeen Bay in the same month), viz., 172, ranging from 145mm. to 178mm.

A third group is better indicated by 41 herrings from 182mm. to 217mm., the modal size being about 196mm., and the average 190.8mm., or a little over 7 inches.

On 25th December, 1901, a collection of 87 herrings was obtained at Burghead Bay, in from  $7\frac{1}{2}$  to 18 fathoms. Two series were present, the first consisting of 19 fish, ranging from 139mm. to 183mm. ( $5\frac{1}{2}$  to  $7\frac{3}{8}$  inches) the mean being 161mm., and the average 162.4mm., or  $6\frac{3}{8}$  inches. These are apparently autumn herrings over three years of age.

The second series consisted of 68 fish, ranging from 186mm. to 223mm. ( $7\frac{5}{8}$  to  $8\frac{3}{4}$  inches); the modal size was about 198mm., the mean 204.5mm., and the average 201mm., or  $7\frac{1}{8}$  inches. These also were autumn herrings over four years of age.

The numbers are not large, but comparison of the sizes of the two groups shows an increment in the year of 39.6mm., or a little over  $1\frac{1}{2}$  inches.

On 1st April, 1904, off Findhorn, in the same neighbourhood, 497 herrings were obtained, the depth of the water in this case being from 30 to 32 fathoms. They were the largest herrings got in any of the collections by means of the otter-trawl. (Plate XVIII.)

Eleven of them belonged to one series, and ranged from 123mm. to 169mm., the mean size being 143mm., and the average computed 150.8mm., or about  $5\frac{1}{8}$  inches.

The next group consisted of 478 herrings, ranging from 177mm. to 228mm. (7 to 9 inches), but the series might stop about 223mm. The modal size was about 200mm., the mean was 202.5mm., and the computed average was 203.2mm. These herrings were therefore about 8 inches long, and they were spring herrings, as their position in the synthetic table shows, a little over four years of age.

Another collection from the Moray Firth was obtained in the Cromarty Firth on 1st June 1901, and of the 70 taken, 66 measured from 111mm. to 155mm. ( $4\frac{3}{8}$  to  $6\frac{1}{8}$  inches); the mode was 135mm. ( $5\frac{1}{8}$  inches), the mean was 133mm., and the computed average 129.7mm. or  $5\frac{1}{8}$  inches.

These were autumn herrings approaching their third year of age.

The next largest herrings measured by me consisted of a "cran" of spring herrings, caught by drift-net, in the ordinary way, on 16th February 1904, in the neighbourhood of the Isle of May, at the mouth of the Firth of Forth, and landed at Anstruther. They were actually spawning, and it was thus a simple matter to separate the sexes and measure them apart, a task in which Mr. William Keir, the Fishery Officer of the district, was good enough to assist me. The measurements will be found in Table III., and the curves on Plate XIX.

A glance at the peculiar curve is enough to show that the herrings do not form a homogeneous group. The range is too great for one series, viz., over 70mm. ( $2\frac{7}{8}$  inches); the oblique line on the synthetic chart connecting the extreme limits of the spring herrings of various ages, when prolonged, goes through the middle of the collective measurements; and consideration of the millimetre table and the curves shows that two groups are present. The males and females were measured separately in two lots each, or four in all, and when curves are made of these separate measurements, they all agree in having two cusps, or modes, with a depression at about 25cm. The following Table shows the grouping in each of the four measurements, in .5cm., and also the arrangement of the 2mm. grouping at the critical place:—

[TABLE.



CENTIMETRES.

	21.5	22	22.5	23	23.5	24	24.5	25	25.5	26	26.5	27	27.5	28	28.5	29	29.5	30	30.5
Males, I.	1	2	9	25	35	24	23	32	35	40	35	14	7	5	5	1	-	1	-
„ II.	-	1	12	20	35	28	32	23	36	27	19	14	7	1	1	-	-	-	-
Total, -	1	3	21	45	70	52	55	55	71	67	54	28	14	6	6	1	-	1	-
Females, I.	-	-	11	19	27	32	34	29	42	34	31	15	9	2	2	3	-	1	-
„ II.	-	-	4	12	25	23	21	19	23	21	14	8	7	2	2	-	-	-	1
Total, -	-	-	15	31	52	55	55	48	65	55	45	23	16	4	4	3	-	1	1

MILLIMETRES.

	235.6	237.8	239.40	241.2	243.4	245.6	247.8	249.50	251.2	253.4	255.6	257.8
Males, I.	14	16	10	11	8	11	9	8	9	18	13	16
„ II.	14	15	13	12	9	15	14	7	8	11	14	16
	28	31	23	23	17	26	23	15	17	29	27	32
Females, I.	10	13	10	10	16	17	14	7	11	14	16	20
„ II.	8	11	10	10	9	9	9	6	5	11	10	9
	18	24	20	20	25	26	23	13	16	25	26	29
Total, -	46	55	43	43	42	52	46	28	33	64	53	61

The younger herrings show the following: - The females, 215 in number, extend from 225mm. to 250mm. ( $8\frac{1}{2}$  to  $9\frac{1}{2}$  inches), viz., to the point where fusion takes place with the older group; but if the curve is continued into the second group, as it ought to be to give the true limit, then herrings of this series will extend to about 26.5cm., or  $10\frac{3}{8}$  inches—perhaps more. The modal size is 24.25cm., according to the .5cm. arrangement of the measurements; according to the millimetre table it is at 244mm. ( $9\frac{5}{8}$  inches); the mean size is 237.5mm., or on the extension of the series to 26.5cm., it is 245mm., and the computed average is 239.9mm., or nearly  $9\frac{1}{2}$  inches.

The males number 256, ranging from 218mm. to 250mm. ( $8\frac{5}{8}$  to  $9\frac{1}{2}$  inches, or further, as described for the females); the mode is 23.5cm., according to the .5cm. arrangement, and according to the millimetre table 237mm. ( $9\frac{3}{8}$  inches); the mean is 234mm., or, if the group is extended, 241.5mm. ( $9\frac{1}{2}$  inches), and the computed average is 236.7mm., or  $9\frac{5}{8}$  inches.

The figures for the two sexes grouped together are 471 herrings, ranging from 218mm. to probably 26.5cm. ( $8\frac{5}{8}$  to  $10\frac{3}{8}$  inches), a range of 47mm. The modal size is 238mm. ( $9\frac{3}{8}$  inches), and the average 237.7mm., or the same.

These spring herrings are five years of age, and they appear to be the first annual series which attains maturity.

The second group of herrings comprised 248 females and 282 males. The beginning of the series is where the fusion with the younger series occurs, at 251mm., but it probably extends back to about 23·5cm. (9½ inches), judging from the form of the curve. The place where it ends is not so immediately clear. The following shows the arrangement in 2mm. groups:—

	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300	302	304	306	308
Female.	11	7	11	5	5	2	1	2	2	—	2	1	—	—	—	1	—	1	—	—
Male.	14	11	7	8	3	2	2	4	4	—	1	—	—	—	—	—	—	1	—	—
	25	18	18	13	8	4	3	6	6	—	3	1	—	—	—	1	—	2	—	—

And the measurements under the millimetres are these:—

	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291
Female.	3	2	4	1	2	1	—	1	—	2	1	1	—	—	2	—
Male.	3	5	2	1	1	1	—	2	2	2	2	—	—	—	1	—
	6	7	6	3	3	2	—	3	2	4	3	3	—	—	3	—

It appears from this that the group terminates at 281mm. (11½ inches), the rest of the herrings belonging to, at least, one older group. The modal size is 257mm. (10½ inches), the mean is 266mm. (or 261mm. on the extension of the group back to 240mm.), and the average as computed is 262·1mm. (10½ inches).

The males begin and end like the females, have exactly the same modal size, while the computed size is 261mm.

The group comprising both sexes contains 530 herrings, with the same range, modes, and means, the computed average size being 261·5mm. These herrings are six years of age.

The rest of the herrings numbered 10 females and 12 males; the former ranged in size from 283mm. to 305mm. (11½ to 12 inches), and the latter practically the same, 283mm. to 304mm. These herrings are seven years old, and although the range of size shown is only 22mm. and 21mm., it is probable, judging from the 2mm. table given above, that the three herrings at about twelve inches (300mm., 304mm., 305mm.) are at least a year older still. Growth in length, as is well known, is much retarded when the fish attain to maturity and afterwards, as is shown, indeed, by comparing the modal sizes of the two series under discussion, the growth indicated in a year being only about 19mm. (¾ inch).

It will be noticed that in both series the males are more numerous than the females, and that, while in the second or older series the size of the males and females is the same, the males in the first group are appreciably smaller than the females. In both lots of males of this series measured, the mode in the ·5cm. curves is at 23·5cm.; in the older group one of the modes is at 25·5cm.; and the other at 26cm. When all the males are considered together, the mode in the ·5cm. curve is at 23·5cm. in the younger group and at 25·5cm. in the older group. In the two lots of females, the cusp in one case in the younger group was at 23·5cm., and in the other at 24·5cm.; in the older group both the cusps or modes were at 25·5cm.

There was thus a greater number of small males than of small females in the younger series, but this does not necessarily denote that the male reaches maturity at a smaller size than the female.

In March, another lot of these spring herrings from the Forth were measured. They were forwarded to the laboratory, and placed in weak formaline solution for a time; they were measured by the laboratory attendant, who also determined the sexes in most of them by opening the fish; doubtful cases were determined by myself.

The herrings numbered 1155, of which 514 were females and 641 were males. Most of them were spawning, but 40 females and 43 males were spent. The herrings as a whole were smaller than those got in February. Whether this was due to any extent to their having been soaking in weak formaline solution is doubtful; my experience with other fishes is that they do not appreciably diminish in length under such circumstances. The fact that they were measured by another person has to be kept in view, but, making all due allowances, I think it may be assumed that these herrings were on the whole smaller than those in the previous month.

The table of measurements and the curve (Plate XIX.) show that the bulk of the herrings was composed of two annual series, but it is not very clear where the division occurs in this case. Theoretically, it should be about 24.5cm., and a consideration of the curves and tables suggests that it should be placed at 244mm.; but the division is somewhat arbitrary. The separate curves for the sexes does not help much, except in the case of the males, where there are cusps or modes at 23cm. and 25cm., the depression being at 24cm.

To this series belong 256 females and 319 males. Both have a similar range, from 211mm. to 244mm. (but the latter is no doubt greater, and possibly goes to over 25cm.); the modal size for each may be put at 23.5cm. ( $9\frac{1}{2}$  inches); the means are 227.5mm. (or, if the series is extended to 254mm.—a centimetre more—it is 232.5mm.); the computed average sizes are, for females 232.8mm., and for the males 232.2mm.

Combining both sexes, the group of 575 herrings have the same range as above, the same modes and means, and the average size is 232.5mm., or  $9\frac{3}{16}$  inches.

The second series of herrings begins about 245mm., or, if extended for 1cm. backwards, at 235mm. ( $9\frac{1}{2}$  inches). Where it ends is not so clear. The 2mm. grouping is as follows:—

267	260	271	273	275	277	279	281	283	285	287	289	291
18	14	13	12	5	4	2	2	1	—	2	1	—

and the millimetre measurements are:—

271	272	273	274	275	276	277	278	279	280	281	282	283	284	285
8	8	4	2	3	2	2	1	1	1	1	—	1	—	—

It might end at 281mm., or 274mm., or at 277mm., and I take the latter ( $10\frac{1}{2}$  inches).

To this group belong 252 females and 317 males. Both have the same range, 245mm. (or 235mm.) to 277mm.; the modal size is about 25cm. ( $9\frac{1}{2}$  inches); the means are 261mm. (or 256mm.); and the computed averages are, for the males 252.7mm. (almost 10 inches), and for the females 254.1mm. (10 inches). The group of 569 herrings has the same range, mode, and mean as described, and the computed average is 253.5mm.

The difference between the first and the second series in the March herrings (on the averages) is, for females 21.3mm., for males 19.9mm., and for the series combined 21.0mm.

There were other eleven herrings of larger size in the collection, viz., six females, measuring 281mm., 283mm., 287mm., 288mm., 324mm., and 325mm.; and five males, measuring 278mm., 279mm., 280mm., 287mm., and 304mm.

These obviously belong to different annual series. It is very probable that the herring at 304mm. represents an older group than those smaller, while the two large females ( $12\frac{1}{2}$  inches) must be some years older.

With regard to the spent herrings, it may be noted that 13 females and 8 males belonged to the first series, and 24 females and 35 males to the second series. The two large females were spent and another at 288mm. The grouping of the spent fish in .5cm. is as follows:—

	21.5	22	.5	23	.5	24	.5	25	.5	26	.5	27	.5	28	.5	29	.5	30	.5	31	.5	32	.5
Males,	1	-	1	2	5	4	5	4	8	4	1	2	-	1	-	-	-	-	-	-	-	1	1
Females,	-	-	-	5	2	1	7	13	7	1	3	3	1	-	-	-	-	-	-	-	-	-	-
	1	-	1	7	7	5	12	17	15	5	4	5	1	-	1	-	-	-	-	-	-	1	1

#### 8. CONCLUSIONS.

It is evident from the above account that the herring grows slowly, and that those authors who supposed that it might reach the mature condition in a year or eighteen months were very wide of the mark.

At the end of the year in which it was born, that is to say, in December, the spring herring rarely exceeds 50mm. (2 inches), and the great majority are much smaller; at the same period, the autumn herring may be as small as 14mm. (a little over  $\frac{1}{2}$  an inch), and is rarely over  $1\frac{3}{4}$  inches, or 35mm. This difference between the spring and autumn herring, it may be said, persists throughout. There is nothing to indicate that the rate of growth is greater in one than in the other, an interval of about 1.5cm.-2cm., or a little more, separating the mean sizes of the two classes at the same date. This is what might be expected, since an interval of five or six months intervenes between the spawning periods, and the difference in size between the spring and autumn herrings thus represents about half the amount of the growth in a year.

While both autumn and spring herrings are included in the collections with which I have dealt in this paper, those of the latter are the most complete; and I have set forth on the accompanying table the particulars regarding a number of the collections in order to show, in collective fashion, the rate of growth and the age at different sizes. Though these collections belong to different years and to various localities (but all on the east coast of Scotland), it will be seen that there is a very considerable uniformity of results.

The monthly rate and the annual rate of growth, it may be said, are calculated from a larger number of decimals than the rate per day, and the age is computed from the middle of March. It will be observed that the growth in the summer months is much more rapid than in the colder part of the year; and the mean annual rate of growth in the four best cases, where the period is long and the numbers of herrings considerable, is 43.4mm., or about  $1\frac{3}{4}$  inches. If the rate between January and May is included (49.6) the mean rate is 44.6mm.

[TABLE.

Date.	Place.	No. of Her- rings.	Range in Size.		Mode, or Size of Greatest Frequency.		Probable Approximate Age.		Increase in Interval.	No of Days from Previous Entry.	Rate of Increase.		
			Mm.	Mm.	Inches.	Yrs.	Mos.	Per Day.			Per Month.	Per Year.	
April, . . . . .	Various, . . . . .	-	6-17	-	-	-	-	1	-	-	-	-	-
June, . . . . .	Various, . . . . .	-	13-26	3	(19.5)	3	-	3	-	-	-	-	-
18th, 20th September 1900,	Aberdeen Bay, . . . . .	194	21-44	32.5	14	14	-	6	13	(90)	.144	4.39	-
12th December 1903,	Aberdeen Bay, . . . . .	15	(42)-50	45	14	14	-	9	13.5	85	.159	4.83	-
19th, 20th January, . . . . .	St. Andrews Bay, . . . . .	11	42-56	48	14	14	-	10	3.0	38	.079	2.40	-
*6th February 1892, . . . . .	Firth of Forth, . . . . .	240	45-(69)	(57)	24	24	-	10½	(9.0)	18	(.500)	(6.0)	-
*29th April 1890, . . . . .	Firth of Forth, . . . . .	786	45-(76)	(60.5)	24	24	1	-	(3.5)	82	(.043)	1.29	-
9th-13th May 1901, . . . . .	Firth of Forth, . . . . .	277	94-139	113	4½	4½	2	14	465	477	.136	4.14	49.6
18th December 1900, . . . . .	Aberdeen Bay, . . . . .	405	114-161	141	5½	5½	2	9	28	218	.123	3.90	46.8
30th May 1901, . . . . .	Aberdeen Bay, . . . . .	598	142-186	159	6½	6½	3	2½	18	164	.109	3.83	40.0
28th June 1901, . . . . .	Lunan Bay, . . . . .	650	148-192	167	6½	6½	3	3½	8	29	.276	8.38	100.6
1st April 1904, . . . . .	Off Findhorn (Moray Firth)	478	177-228	200	7½	7½	4	0½	33	276	.120	3.63	43.6
16th February 1904, . . . . .	Firth of Forth, . . . . .	471	218-250 (265)	238	9½	9½	4	11	38	321	.118	3.60	43.2
16th February 1904, . . . . .	Firth of Forth, . . . . .	530	251-281 (240)	257	10½	10½	5	11	19	365	.052	1.58	19.0

\* Garland's collections transferred from inches to millimetres.

† The calculation is from January.

Growth in length, however, as with most fishes, is somewhat more rapid in the early stages, and diminishes with age, at first very slowly, and then on the occurrence of sexual maturity with great and marked rapidity.

The following gives the main features of the growth of the herring, according to this investigation :—

Approximate Age.	Length.		Increase in Length from Previous Year.	
	Mm.	Inches.	Mm.	Inches.
1 Year, . . . . .	60·5	2 $\frac{3}{8}$	—	—
2 Years, . . . . .	113	4 $\frac{7}{16}$	52	2 $\frac{1}{16}$
3 „ . . . . .	159	6 $\frac{1}{4}$	47	1 $\frac{1}{2}$
4 „ . . . . .	200	7 $\frac{1}{2}$	41	1 $\frac{1}{4}$
5 „ . . . . .	238	9 $\frac{1}{2}$	38	1 $\frac{1}{2}$
6 „ . . . . .	257	10 $\frac{1}{4}$	19	$\frac{1}{2}$

The herring, both male and female, appears to attain the mature condition, and to reproduce for the first time, when it is five years of age.

If the same rate of growth as is indicated above between the fifth and sixth years be assumed to continue during the next few years, the approximate average sizes of older herrings would be as follows:—7 years, 276mm. (10 $\frac{1}{4}$  inches); 8 years, 295mm. (11 $\frac{1}{2}$  inches); 9 years, 314mm. (12 $\frac{3}{8}$  inches); 10 years, 333mm. (13 $\frac{1}{8}$  inches). It is certain, however, that the growth in the later series of larger herrings is not nearly so rapid as this, and herrings over 12 inches are probably more than ten years old. The larger herrings of 13 to 15 inches, such as are referred to on a former page, must be very old; the latter probably from fifteen to twenty years.

It may be of interest now to compare briefly the results as stated above and those obtained by Jenkins and Masterman. The research of the former, as previously mentioned, was made on the otoliths of spring herrings of the Baltic, and the precise age could not, therefore, be determined with certainty, not within several months. The research of Masterman was on both spring and autumn herrings at St. Andrews, but was confined to specimens taken in tow-nets—to larval and post-larval forms, and to small numbers of young herrings obtained in the same way—and so far as his research was carried it agrees well with my own. He did not attempt to deal with the growth of the older series of herrings, except in a few cases, but made certain calculations as to the rate of growth per month. In the following Table I give a summary of the results of Jenkins (as amended by the intercalation of a year, so as to make his annual series a year older than he represents them), and also of the results of Masterman on the spring herring, as far as they go, and the approximate sizes of the older series as calculated on the basis he gives, viz., a growth of from 4mm. to 5mm. per month. The latter is quite accurate for the early stages, but it is rather wide of the mark for the older herrings, owing to the diminution of the rate of growth with age that actually takes place.

Year of Age.	I.			II.		III.			
	Year.	Range.	Mean.	Mean.	Range.	Observed	Computed.		
							Min.	Max.	Mean.
1	...	...	...	60.5	45-76	62	...	...	...
2	(1)	113-121	117	113	94-139	112	110	122	116
3	(2)	156-164	160	159	142-186	...	158	170	164
4	(3)	190-198	194	200	177-228	...	206	218	212
5	(4)	217-225	229	238	218-265	...	254	266	260
6	(5)	237-245	241	257	240-257	...	302	314	308

Column I. shows Jenkins' results, Column II. shows my own results, and Column III. shows the results obtained by Masterman, and the size at the later stages, computed at the mean rate of increase of 4mm. to 5mm. It will be observed that my results and those of Jenkins agree remarkably well, when a year is added to the age he assigns to his various series.

In the later work of Masterman and M'Intosh (17a) it is suggested that 3 inches (76mm.) and 5 inches (127mm.) represent a rough average of the size of the herring when one year and two years of age respectively; and that sexual maturity is attained when it is between 8 and 9 inches (203-228mm.) in length and probably three years of age. This, however, involves a more rapid growth than the facts warrant, and is not consistent with the results of Masterman's own earlier paper.

The earlier authors referred to at the beginning of this paper as a rule under-estimated the rate of growth of the herring. The most correct are those of Malm, Sars and Nilsson. It is interesting to observe that the estimate of the fishermen of Bohuslän, Sweden, as given by Nilsson, is accurate; and that the estimates of the Scottish fishermen (three or seven years) was much nearer the truth than those of the naturalists.

The elucidation of this question of the growth of the herring has an important bearing on several fishery problems. Compared with most fishes caught by lines or trawls, it is clear that the herring, caught by drift-nets, has a great advantage, inasmuch as no immature herrings are caught in this way, no less than four generations of undersized or immature herrings escaping through the meshes.

It may also help to explain such problems as the presence every summer for a period of years of large herrings in the deep water of Upper Lochfyne, and their absence for a period of years. It is quite possible that these herrings belong to one and the same shoal, which has accustomed itself to the route of migration and the locality, and which is ultimately fished out or destroyed. It may also serve to explain the presence in the loch of small herrings in autumn and winter without supposing that they were spawned there. Such little herrings are one year old and more, and could therefore easily make their way into the loch from the spawning grounds in the outer part of the Clyde.

## LITERATURE.

1. HUXLEY, T. H.—"Report of the Royal Commission on the Operation of the Acts relating to Trawling for Herring on the Coasts of Scotland." 1863, p. 27.
- 1A. —.—"Nature." XXXI. 1881, p. 607.
2. MITCHELL, J. M. "The Herring: Its Natural History and National Importance." 1864.
3. YARRELL, W.—"A History of British Fishes." 1859.
4. DE CAUX.—"The Herring and the Herring Fishery." 1881, p. 50.
5. SIM, G.—"The Natural History of the Herring." 1883, p. 46.
6. LJUNGMANN, A. V.—"Om sillens och skarpsillens fortplantning och tillväxt." 1879. Nordisk Tidskrift för Fiskeri. V. 193.
- 6A. —.—"Bidrag till kännedomen om sillens lefnadsförhållanden." 1880.
7. WIDEGREN, H.—"Några ord om sillfiske samt om sillens eller Strömmingens rätta beredning till handelsvara." Tidskrift för Fiskeri, 6 Aarg., X., 1871.
8. BOECK, A.—"Om Silden og Sildefiskerierne," p. 13.
9. SUNDEVALL, C. J.—"Stockholms läns K. Hush. Sällsk. Handl." VI., p. 105.
10. EKSTROM, C. U.—"Praktisk Afhandling," p. 10.
- 10A. —.—"Danmarks Fiske," III., pp. 170, 171.
11. NILSSON, S.—"Handlingar rörande Sillfisket," p. 45.
12. SÆRS, G. O.—"Indberetning til Departementet for det Indre," 1870-73, pp. 38, 39.
13. MALM, A. W.—"Göteborgs och Bohusläns Fauna." 1877, p. 581.
14. HOEK, P. P. C.—"The Fishes of the Zuiderzee" (Tijdschrift der Nederlandsche Dierkundige Vereeniging (2), III. Af. I. 1890).
- 14A. —.—"Bericht über die Fischerei mit Steerthamen." (*Ibid.* Suppl. Deel II. 1888).
15. MEYER, H. A.—"Biologische Beobachtungen bei künstlicher Aufzucht des Herings der westlichen Ostsee." 1878.
- 15A. —.—"Beobachtungen über das Wachstum des Herings im westlichen Teile der Ostsee" (Jahresbericht der Komm. z. wiss. Untersuch. der deutschen Meere in Kiel, 1878, 227).
16. JENKINS, J. T.—"Altersbestimmung durch Otolithen bei den Clupeiden." (*Ibid.* Neue Folge, 8th Bd. Abtheil., Kiel, p. 83). 1902.
17. MASTERMAN, A. T.—*Fourteenth Annual Report, Fishery Board for Scotland*, Part III., p. 294. 1896.
- 17A. M'INTOSH AND MASTERMAN.—"British Marine Food Fishes," pp. 420, 422 (1897).
18. CUNNINGHAM, J. T.—"Marketable Marine Fishes of the British Islands," p. 162.
19. MATTHEWS, J. D.—*Fourth Annual Report, Fishery Board for Scotland*, 1896.
- 19A. —.—*Fifth, ibid.*, 1887.
20. BROOK, G.—*Fourth, ibid.*, p. 48.
21. MURIE, J.—"Kent and Essex Sea Fisheries Committee—Report on the Sea Fisheries, &c., of the Thames Estuary." 1903.
22. LUNDBERG, R.—"Bidrag till kännedomen om Strömmingen i Stockholm-skärgård." 1875.
23. TRYBOM, —.—"Iakttagelser vid Sillfisket i Bohuslän." 1883.
- 23A. —.—"Sillundersökningar vid Sveriges Vestkust." 1889.
24. "Verslag van den Staat der Nederlandsche Zeevisscherijen over 1863," p. 15.
25. M'INTOSH, W. C.—"Seventh-Twelfth Reports of the Fishery Board for Scotland, Part III.
26. MURRAY, G.—*Fifteenth Annual Report of the Fishery Board for Scotland*, Part III.

## EXPLANATION OF PLATES XVII.-XIX.

The diagrams shown on the plates represent the measurements of the various collections of herrings dealt with, the measurements being shown in 5cm. groups.



TABLE I.—ABERDEEN BAY.

Cm.	Feb.	Mar.	Apr.	May	June.				July	Aug.*	Sept.	October.			November.			December.					
	11,	29,	24,	30,	10,	13,	28,	5,	21,	18,	3,	18,	31,	6,	6,	9,	23,	12,	18,	17,	19,	29,	
	1905	1905	1906	1901	1902	1904	1903	1901	1901	1901	1900	1901	1900	1903	1901	1900	1903	1900	1903	1900	1901	1900	1903
1	-	-	-	-	-	3	-	-	19	-	1	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	3	-	82	-	-	10	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	6	216	-	-	112	-	-	2	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	26	33	-	-	58	-	-	1	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	66	2	-	-	1	-	-	2	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	65	-	-	-	-	-	-	1	-	-	-	-	-	-
5	-	-	130	-	-	-	-	-	-	31	-	-	-	-	-	-	-	-	4	-	-	-	-
5	-	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-
5	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-
5	-	-	-	-	×	18	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	×	5	-	-	-	-	-	-	48	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	×	-	-	-	-	-	-	-	104	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	113	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	92	-	-	1	-	-	-	-	1	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	122	-	-	1	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	1	94	-	1	1	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	70	-	1	-	-	-	-	-	3	-	-
5	-	-	-	-	-	-	-	-	-	-	-	5	43	-	1	-	-	1	-	-	2	-	-
10	1	-	-	-	-	-	-	-	-	-	-	17	54	-	4	1	-	1	-	1	-	-	-
5	1	-	-	-	-	-	-	-	-	-	-	54	43	-	6	-	-	1	1	4	-	1	
11	-	-	-	-	-	-	-	-	-	-	-	103	22	-	9	-	-	2	4	5	1	1	
5	1	-	-	-	-	1	-	-	-	-	-	105	12	-	3	2	-	10	10	2	2	-	
12	-	-	-	-	-	12	-	-	-	-	-	57	2	-	2	2	-	1	32	12	1	3	
5	-	1	-	-	-	42	-	-	-	-	-	42	1	-	2	-	1	39	5	-	3	-	
13	-	-	-	-	-	72	-	-	-	-	-	29	3	2	1	3	-	56	4	1	1	-	
5	-	-	-	-	-	103	-	-	-	-	-	15	2	2	-	4	-	72	4	-	1	-	
14	-	-	-	2	-	96	-	3	-	-	-	6	2	2	-	5	-	89	-	-	2	-	
5	-	-	-	12	-	75	2	2	-	-	-	1	-	-	-	-	-	69	2	-	1	-	
15	-	-	-	46	-	54	10	1	-	-	-	2	-	-	-	-	1	25	-	-	1	-	
5	-	-	-	165	-	49	41	1	-	-	-	1	1	-	-	-	-	8	1	-	-	-	
16	-	-	-	176	-	25	96	1	-	-	-	1	-	-	-	-	1	4	-	-	-	-	
5	-	1	-	122	-	13	200	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	
17	-	1	-	53	-	9	173	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
5	-	-	-	18	-	1	93	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	
18	-	-	-	3	-	1	28	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	
5	-	-	-	1	-	-	6	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-	
19	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
5	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
5	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
5	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
5	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
24	3	4	167	001	-	24	557	650	8	22	194	234	444	830	1180	28	22	6	5	21	410	47	19

\* 10 miles off.

TABLE II.—MORAY FIRTH.

Cm.	DORNOCH FIRTH.													BURGHHEAD BAY.				FIND- HORN.	CROMARTY FIRTH.	
	Feb.	Mar.	Oct.	November.						December.				December.				April.	Jan.	June.
	9,	31,	21,	-	5,	6,	11,	12,	11- 12,	26,	7,	25,	28,	6-7,	25,	29,	28,	1,	16,	1,
	1905	1904	1903	1903	1900	1900	1903	1903	cmb	1903	1904	1900	1903	1904	1901	1903	1903	1904	1901	1901
1	-	-	2	3	-	-	4	-	-	1	-	-	-	-	-	*	†	-	-	-
·5	-	-	25	74	-	-	25	-	-	18	-	-	-	-	16	-	-	-	-	-
2	-	-	1	77	-	-	18	-	-	17	-	-	-	-	17	-	-	-	-	-
·5	-	-	-	2	-	-	1	-	-	9	-	-	-	-	13	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	6	-	-	-	-	10	-	-	-	-	-
·5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
·5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
·5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
·5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
·5	-	-	-	-	x	-	1	1	2	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	6	2	6	7	13	-	-	-	-	-	-	1	-	-	-	-
·5	-	-	-	-	16	1	22	31	53	-	-	-	-	-	-	1	-	1	-	-
9	-	-	-	-	19	4	22	98	120	-	-	-	-	-	-	-	-	4	-	-
·5	-	-	-	-	13	1	23	216	239	-	-	3	-	-	-	1	-	5	-	-
10	-	-	-	-	20	-	12	257	269	-	-	9	-	-	-	2	-	2	1	-
·5	3	2	-	-	66	-	13	244	257	-	3	91	1	-	-	1	-	2	-	-
11	-	5	-	-	179	-	3	158	161	-	4	296	-	-	-	2	-	4	2	-
·5	3	3	-	-	167	1	6	116	122	-	1	411	-	-	-	1	-	1	6	-
12	-	2	-	-	70	-	2	63	65	-	-	343	1	1	-	1	1	6	8	-
·5	-	2	-	-	34	-	-	83	33	-	-	257	1	-	-	4	-	4	10	-
13	-	1	-	-	8	-	12	12	-	-	150	-	-	-	1	-	1	1	8	-
·5	-	1	-	-	4	-	6	6	-	-	112	-	1	1	1	-	-	-	12	-
14	-	-	-	-	2	1	4	4	-	-	97	1	-	1	1	-	1	2	9	-
·5	-	-	-	-	4	-	2	2	-	-	84	-	-	5	-	-	1	1	6	-
15	-	-	-	-	2	-	1	1	-	1	48	-	-	-	-	-	1	-	3	-
·5	-	-	-	-	-	1	-	-	-	-	25	-	-	1	-	-	2	-	2	-
16	-	-	-	-	2	-	2	2	-	-	9	-	1	1	-	-	3	-	1	-
·5	-	-	-	-	-	-	10	10	-	-	2	-	3	3	-	-	1	-	-	-
17	-	-	-	-	-	-	18	18	-	-	1	-	2	1	-	-	-	-	1	-
·5	-	-	-	-	-	-	16	16	-	-	3	-	2	3	-	-	2	-	-	-
18	-	-	-	-	-	-	15	15	-	-	6	-	-	3	-	-	9	-	-	-
·5	-	-	-	-	-	-	15	15	-	-	7	-	-	9	-	-	22	-	-	-
19	-	-	-	-	-	-	7	7	-	-	6	-	-	11	-	-	40	-	-	-
·5	-	-	-	-	-	-	4	4	-	-	9	-	-	17	-	-	63	-	1	-
20	-	-	-	-	x	1	-	-	-	-	5	-	-	13	-	-	108	-	-	-
·5	-	-	-	-	x	2	-	-	-	-	4	-	-	7	-	-	99	-	-	-
21	-	-	-	-	x	1	-	-	-	-	3	-	-	6	-	-	69	-	-	-
·5	-	-	-	-	-	-	-	-	-	-	1	-	-	3	-	-	36	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	19	-	-	-
·5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
·5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
·5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
	8	10	28	156	601	15	158	1336	1446	51	10	1982	4	10	87	59	14	497	33	70

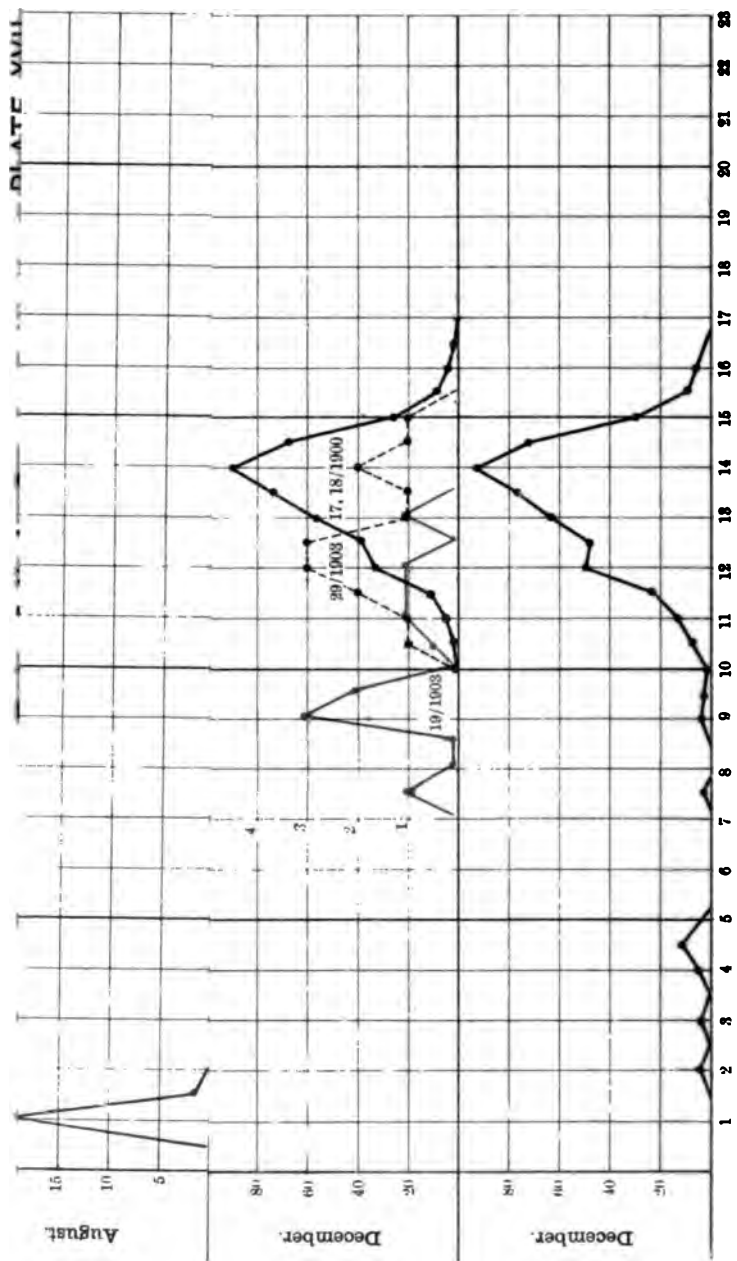
\* 30 Fathoms.

† 30-32 Fathoms.

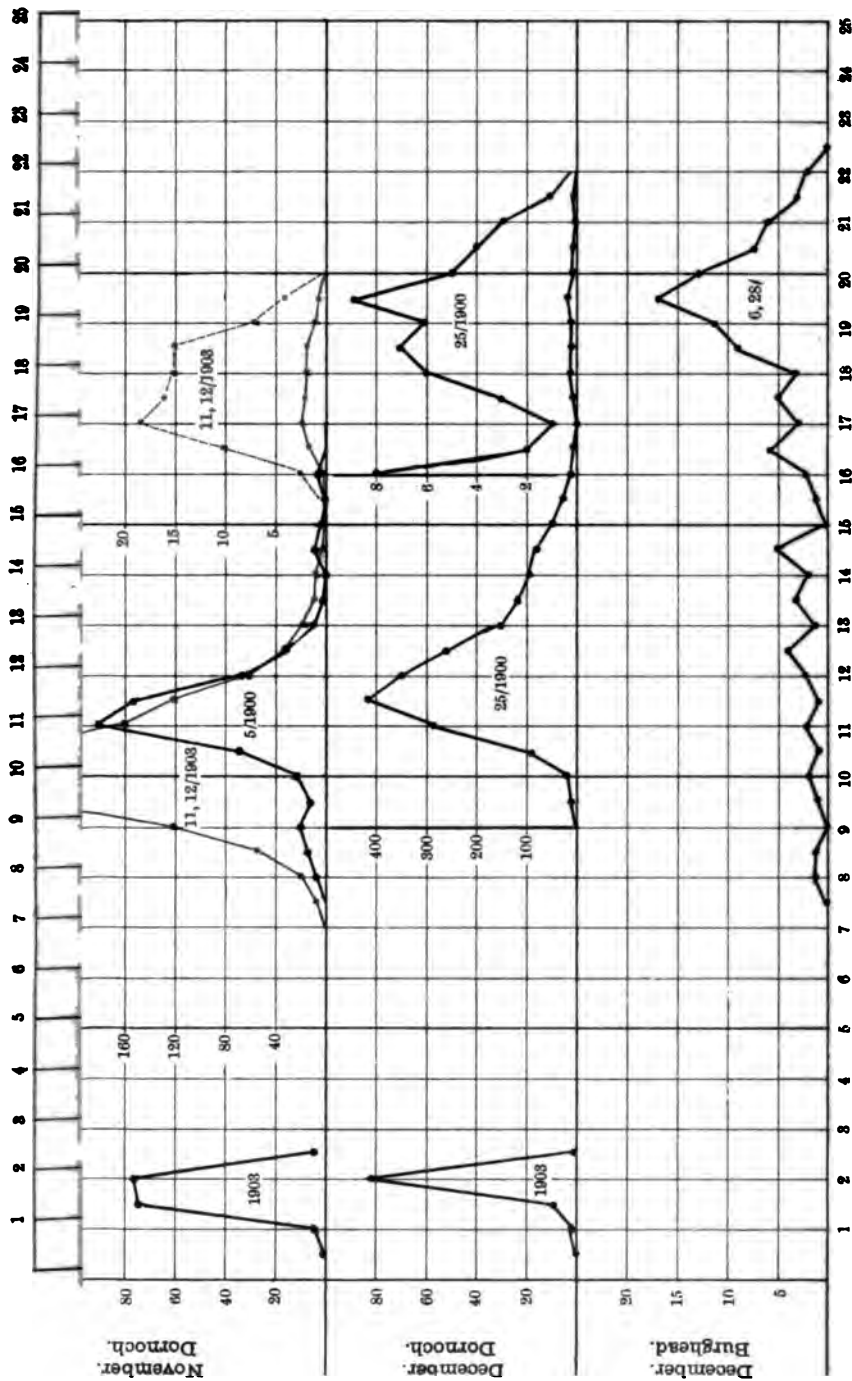


TABLE III.—FIRTH OF FORTH—continued.

Cum.	February		Mar.	April.		May.		Aug.	Sept.	Oct.	Dec.	May.					July.	Sept.	February, 10, 1904.		
	17- 21, 1890	6, 1892	17- 22, 1890	26- 20, 1890	20, 1892	9-15, 1890	7-9, 1890	5, 1891	3-5, 1890	10- 19, 1890	9- 10, 1892	9, 1901	10, 1901	13, 1901	9, 10, 13, com 1901	28, 1901	23, 1901	4, 1904	Spawning.		
																			F.	M.	TL
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	21	36
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31	45	76
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	70	122
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55	52	107
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55	55	110
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	48	55	103
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	65	71	136
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55	67	122
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45	54	99
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23	28	51
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	14	30
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	6	10
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	6	10
29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	1	4
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	19	240	449	1075	312	194	13	3	2423	47	9	161	12	114	237	31	8	48	473	550	102





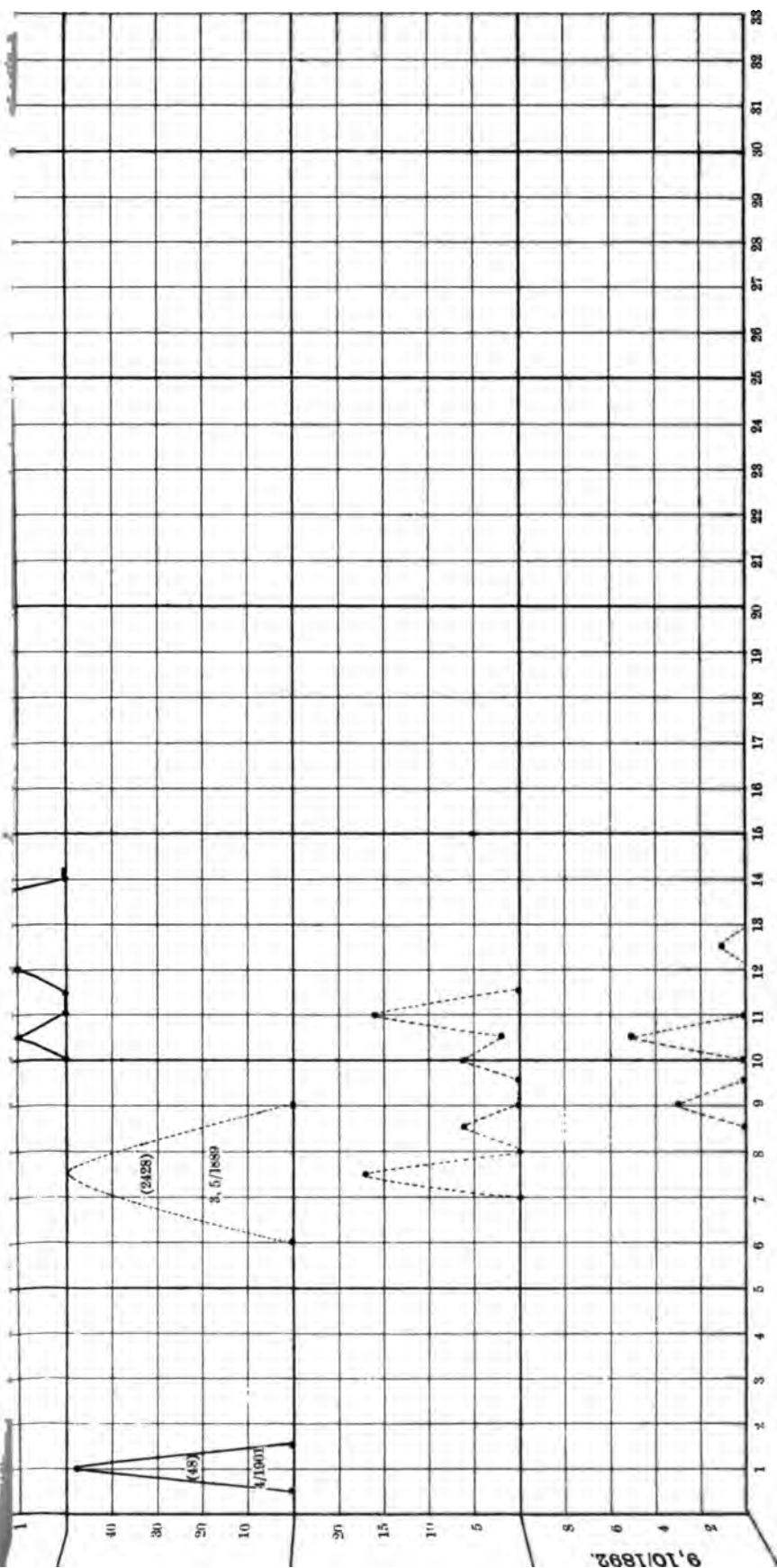






# Herring. III. Fifth of Forth.

PLATE XIX.





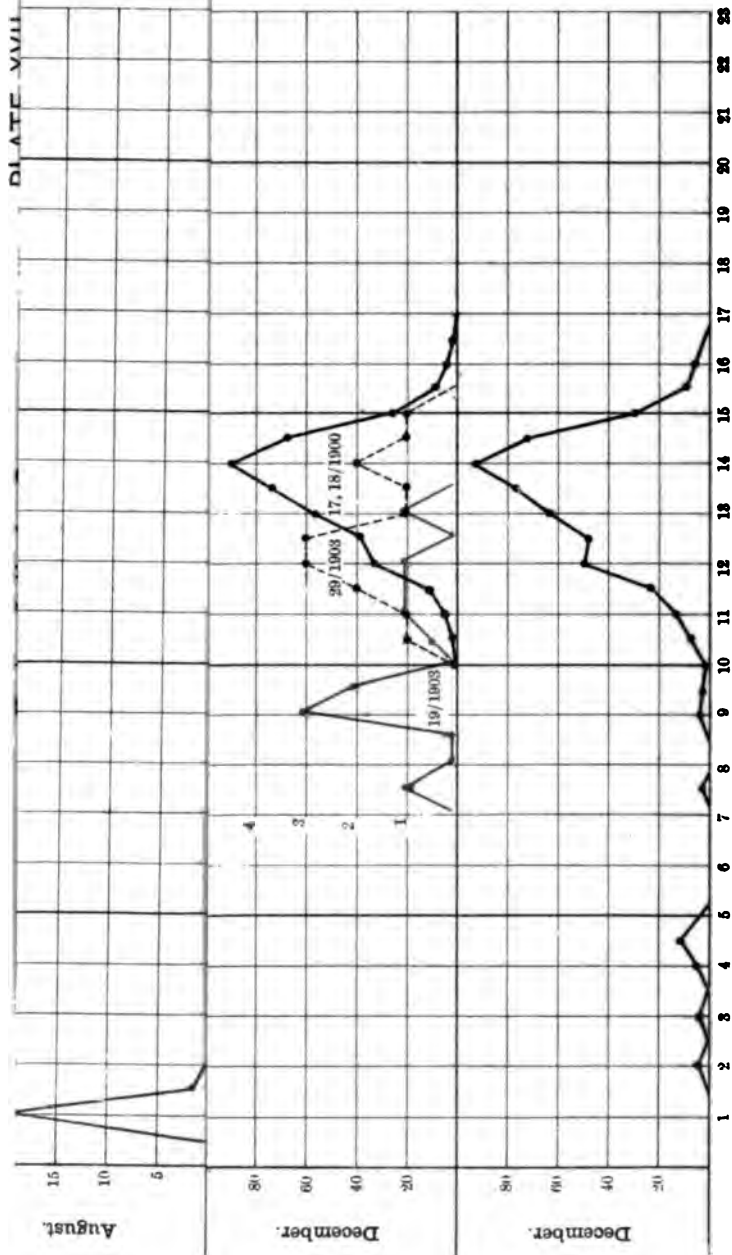
# INDEX.

- ABERDEEN Bay : Trawling investigations in, 25.  
*Acartia biflosa*, 277.  
 Age of Herring, 293.  
 — Brill at maturity, 209.  
 — Herring at maturity, 332, 336.  
 — Lemon Dab at maturity, 196.  
 — Turbot at maturity, 203.  
*Ameira longicaudata*, 277.  
*Amphiascus Catherinae*, 275.  
 — *minutus*, 275.  
 Angler (*Lophius piscatorius*) : Otoliths of, 57.  
 Argentine (*Argentina sphyraena*) : Otoliths of, 76.  
 BALLAN Wrasse (*Labrus bergyllta*) : Otoliths of, 61.  
*Beatricella mimica*, 277.  
 Bib : see Brassy.  
 Black Sole (*Solea vulgaris*) : Otoliths of, 75.  
 Blue-mouth (*Scorpena dactyloptera*) : Otoliths of, 55.  
 Brassy (*Gadus luscus*) : Otoliths of, 63.  
 — Reproduction of, 130.  
 — Ripe eggs of, 131.  
 — Specific characters of, 116, 133.  
 Brill (*Rhombus beris*) : Age of, at maturity, 209.  
 — Growth of, 203.  
 Butter-fish (*Pholis gunnellus*) : Otoliths of, 59.  
*Canthocamptus parvus*, 277.  
*Cannella perplexa*, 277.  
 Cat-fish (*Anarrhichas lupus*) : Otoliths of, 59.  
*Cleododes similis*, 277.  
 Coal-fish (*Gadus virens*) : Otoliths of, 65.  
 Cod (*Gadus callarias*) : Otoliths of, 61.  
 — Growth of, 209.  
 — Growth of, at Iceland, 211.  
 — Hermaphroditism in, 290.  
 Commercial trawlers : Employment of, 17.  
 Composition of Herring, 83.  
 — of muscles and ovaries in Herrings, 99.  
 — of muscles and testes in Herring, 100.  
 Conger (*Conger niger*) : Otoliths of, 79.  
 Copepoda : Rare, from Scottish seas, 275.  
 Couch's Whiting (*Gadus poutassou*) : Otoliths of, 64.  
 Cunningham, Mr. J. T., on growth of Herring, 298.  
 DAB, Common (*Pleuronectes limanda*) : Otoliths of, 74.  
 — Growth of, 189.  
*Dactylopusia brevicornis*, 276, 277.  
 — *finmarchicus*, 277.  
 — *vulgaris*, 277.  
 Description of new fish-hatchery, 108.  
 Differences between male and female Lumpuuckers, 170.  
*Diosaccus propinquus*, 278.  
 — *tenuicornis*, 279.  
 Dragonet (*Callionymus lyra*) : Otoliths of, 58.  
 — Spotted (*Callionymus maculatus*) : Otoliths of, 58.  
 Duration of embryonic development in the Herring, 303.  
 EARSTONES : see Otoliths.  
*Ectinosoma curticornis*, 277.  
 Eel, Common (*Anguilla vulgaris*) : Otoliths of, 79.  
 Eggs of Lumpuucker : Paternal guardianship of, 169.  
*Enhydrosoma incurvatum*, 277.  
*Euryte longicauda*, 277.  
 FAT : Utility of storage of, in fishes, 181.  
 Fish-hatchery : Description of, 108.  
 Fishes : Rate of growth of, 179.  
 — Utility of storage of fat in, 181.  
 Fecundity of Plaice, 281.  
 Flounder (*Pleuronectes fenus*) : Otoliths of, 73.  
 — Growth of, 191.  
 Food value of Herring, 83.  
 Four-bearded Rockling (*Onos cimbrius*) : Otoliths of, 67.  
 GADID species : Key to diagnosis of, 138.  
*Gadus esmarkii* : see Norway Pout.  
 — *luscus* : see Brassy.  
 — *minutus* : see Poor-cod.  
 Goby, Black (*Gobius niger*) : Otoliths of, 58.  
 — Speckled (*Gobius minutus*) : Otoliths of, 58.  
 Greater Fork-beard (*Phycis blennoides*) : Otoliths of, 66.  
 — Weaver (*Trachinus draco*) : Otoliths of, 57.  
 Grey Gurnard (*Trigla gurnardus*) : Otoliths of, 55.  
 — Growth of, 232.  
 — Relation of temperature to migrations of, 236.  
 Growth of fishes, 179.

- Growth of fishes: A law of growth in relation to maturity, 182.
- Influence of external conditions on, 181.
  - Influence of temperature upon, 182.
  - Modification of, in deeper parts of North Sea, 182.
  - of Brill, 203.
  - of Cod, 209.
  - of Cod at Iceland, 211.
  - of Common Dab, 189.
  - of Flounder, 191.
  - of Grey Gurnard, 232.
  - of Haddock, 226.
  - of Herring, 293.
  - of Herring: Various opinions on, 293, 294, 295.
  - of Herring, male and female, 332.
  - of Herring in larval and post-larval stages, 308.
  - of Herring: Conclusions as to, 334.
  - of Herring, spring and autumn, 334.
  - of Lemon Dab, 192.
  - of Long Rough Dab, 196.
  - of Plaice, 184.
  - of Turbot, 199.
  - of Whiting, 229.
- HADDOCK (*Gadus aeglefinus*): Otoliths of, 62.
- Great catches of small, 29, 31.
  - Growth of, 226.
- Hake (*Merluccius vulgaris*): Otoliths of, 66.
- Halibut (*Hippoglossus vulgaris*): Otoliths of, 69.
- Halicyclops aequoriscus*: 277.
- Harpacticus obscurus*: 277.
- Hatchery, Bay of Nigg, Aberdeen: Report on operations at, 108.
- Hatching of Plaice, 110.
- of eggs of Lumpsucker, 177.
- Helmsdale Herring: Chemical composition of, 93.
- Hermaphroditism in Cod, 290.
- Herring (*Clupea harengus*): Age of, at maturity, 332, 336.
- A criticism of Dr. Meyer's observations on growth of, 303.
  - Chemical analyses of, 83.
  - Chemical composition of Helmsdale, 93.
  - Chemical composition of Lochboisdale, 95.
  - Chemical composition of Lochfyne, 86, 104.
  - Composition of muscles and ovaries in, 99.
  - Composition of muscles and testes, 100.
  - Conclusions as to growth of, 334.
  - Duration of embryonic development in, 303.
  - External differences from Sprat, 167.
  - Food value of, 83.
  - Growth and age of, 293.
  - Growth of, in larval and post-larval stages, 308.
  - Growth and age of, 293.
- Herring, Growth of males and females, 332.
- Growth of spring and autumn fish, 334.
  - Maximum size attained by, 301.
  - Notes on natural history of, 165.
  - Numbers taken in Sprat fishery, 161.
  - Nutritive value of, at different periods, 83.
  - Nutritive value of spent, 103.
  - Otoliths of, 77.
  - Proportions of sexes of, 332.
  - Relation of temperature to growth of, 306.
  - Relation of temperature to spawning periods of, 303.
  - Size of, at maturity, 299, 232.
  - Spawning periods of, 302.
  - Variation of fat in, 101.
  - Variation of fat in ovaries of, 102.
  - Variation of proteids in, 101.
- Idya furcata*, 277.
- *gracilis*, 277.
  - *minor*, 278.
- Immature fish caught by trawl, 29, 31.
- Influence of external conditions on growth of fishes, 181.
- JAGO's Goldsinny (*Labrus rupestris*): Otoliths of, 61.
- Jenkins, Dr. Travis, on growth of Herring, 298, 307.
- Laophonte curticauda*, 278.
- *gracilis*, 278.
  - *hispidula*, 278.
  - *inopinata*, 278.
  - *intermedia*, 278.
  - *littorale*, 278.
  - *longiremis*, 278.
  - *thoracica*, 278.
- Lemon Dab (*Pleuronectes microcephalus*): Age at maturity, 196.
- Growth of, 192.
  - Otoliths of, 73.
- Lesser Fork-beard (*Raniceps raninus*): Otoliths of, 68.
- Sand-eel (*Ammodytes tobianus*): Otoliths of, 69.
  - Weaver (*Trachinus vipera*): Otoliths of, 57.
- Ling (*Molva molva*): Otoliths of, 67.
- Lochboisdale Herring: Chemical composition of, 95.
- Lochfyne Herring: Chemical composition of, 86, 104.
- Longipedia scotti*, 278.
- Long Rough Dab (*Drepanopsetta platessoides*): Otoliths of, 69.
- Growth of, 196.
- Lumpsucker (*Cyclopterus lumpus*): Hatching of eggs of, 177.
- Habits of, 171.
  - Differences between males and females, 170.
  - Otoliths of, 59.

- Lumpsucker, Paternal guardianship of the eggs of, 169.  
 — Rivalry of males, 172.  
 — Spawning of, 169.
- MACKEREL** (*Scomber scombrus*): Otoliths of, 57.  
 Marine fish-hatching: Report on, 108.  
 Masterman, Dr. A. T., on growth of Herring, 298, 308.  
 Maturity of fishes: Remarks on, 24.  
 Maturity: Size of Herring at, 299.  
 Maximum size attained by Herring, 301.  
 Megrim (*Lepidorhombus whiff*): Otoliths of, 71.  
 Meyer, Dr. H. A., on growth of Herring, 295.  
 Migrations of Grey Gurnard: Relation of, to temperature, 236.  
 Milroy, Professor T. H., on the food value of the Herring, 83.  
 Moray Firth: Trawling investigations in, 18, 27, 31, 34.  
 Muller's Top-knot (*Zeugopterus punctatus*): Otoliths of, 71.
- Nannopus palustris*, 278.  
 Norway Haddock (*Sebastes norvegicus*): Otoliths of, 54.  
 Norway Pout (*Gadus esmarkii*): Otoliths of, 64.  
 — Maturity of, 131.  
 — Specific characters of, 116, 134.  
 Notes on natural history of Herring, 165.  
 Notes on natural history of Sprat, 165.  
 Notes on new and rare copepoda, 275.  
 Nutritive value of spent Herring, 103.
- OTOLITHS** of Angler, 77.  
 — of Argentine, 76.  
 — of Ballan Wrasse, 61.  
 — of Black Goby, 58.  
 — of Black Sole, 75.  
 — of Blue-mouth, 55.  
 — of Brassy, 63.  
 — of Brown Trout, 76.  
 — of Cat-fish, 59.  
 — of Cod, 61.  
 — of Coal-fish, 65.  
 — of Common Dab, 74.  
 — of Common Sea-bream, 54.  
 — of Conger, 79.  
 — of Couch's Whiting, 64.  
 — of Dragonet, 58.  
 — of fishes: Observations on, 48.  
 — of Flounder, 73.  
 — of Greater Fork-beard, 66.  
 — of Greater Weaver, 57.  
 — of Grey Gurnard, 55.  
 — of Halibut, 69.  
 — of Haddock, 62.  
 — of Herring, 77.  
 — of Jago's Goldsinny, 61.  
 — of Lemon Dab, 73.  
 — of Lesser Fork-beard, 68.  
 — of Lesser Weaver, 57.  
 — of Ling, 67.  
 — of Lumpsucker, 59.  
 — of Mackerel, 57.  
 — of Megrim, 71.
- Otoliths of Muller's Top-knot, 71.  
 — of Norway Haddock, 54.  
 — of Pike, 77.  
 — of Pilchard, 78.  
 — of Plaice, 72.  
 — of Pollack, 66.  
 — of Poor-cod, 64.  
 — of Red Gurnard, 56.  
 — of Red Mullet, 54.  
 — of Roach, 77.  
 — of Salmon, 76.  
 — of Sand Smelt, 60.  
 — of Sapphirine Gurnard, 56.  
 — of Scald-fish, 72.  
 — of Sharp-tailed Lumpenus, 60.  
 — of Solenette, 75.  
 — of Speckled Goby, 58.  
 — of Spotted Dragonet, 58.  
 — of Sprat, 78.  
 — of Streaked Gurnard, 56.  
 — of Striped Wrasse, 61.  
 — of Thick-lipped Grey Mullet, 60.  
 — of Three-bearded Rockling, 67.  
 — of Turbot, 70.  
 — of Variegated Sole, 75.  
 — of Viviparous Blenny, 60.  
 — of Whiting, 65.  
 — of Witch, 74.  
 — of Worm Pipe-fish, 79.
- Parathelestris hibernica*, 278.  
 Paternal guardianship of the eggs of the Lumpsucker, 169.  
 Perch (*Perca fluviatilis*): Otoliths of, 53.  
 Pike (*Esox lucius*): Otoliths of, 77.  
 Pilchard (*Clupea pilchardus*): Otoliths of, 78.  
 Plaice (*Pleuronectes platessa*): Artificial propagation of, 110.  
 — Duration of spawning of female, 281.  
 — Eggs of, 288.  
 — Fecundity of, 281.  
 — Growth of, 184.  
 — Otoliths of, 72.  
 — Spawning of, 281.  
 — Spawning period of, 111, 281.  
 — Variation of growth with locality, 184.  
*Platyhelipus littoralis*, 278.  
 Pogge (*Agonus cataphractus*): Otoliths of, 56.  
 Pollack (*Gadus pollachius*): Otoliths of, 66.  
*Pontopolites typicus*, 278.  
 Poor-cod (*Gadus minutus*): Otoliths of, 64.  
 — Reproduction of, 130.  
 — Ripe eggs of, 131.  
 — Specific characters of, 116, 133.  
 Powan (*Coregonus lavaretus*): Otoliths of, 76.  
 Proportion of marketable and unmarketable fishes, 17.  
 Proportion of sexes in Herring, 332.  
*Pseudodiosaccus propinquus*, 278.  
*Pseudothalestris major*, 278.
- RATE** of growth of fishes, 179.  
 Red Gurnard (*Trigla pini*): Otoliths of, 56.

- Red Mullet (*Mullus barbatus*): Otoliths of, 54.  
 Reproduction of Brassy, 130.  
 Reproduction of Poor-cod, 130.  
 Rivalry of male Lump-suckers, 172.  
 Roach (*Leuciscus rutilus*): Otoliths of, 77.
- SALMON (*Salmo salar*): Otoliths of, 76.  
 Sand Smelt (*Atherina presbyter*): Otoliths of, 60.  
 Sapphirine Gurnard (*Trigla lucerna*): Otoliths of, 56.  
 Scald-fish (*Platophrys laterna*): Otoliths of, 72.  
 Sea-bream, Common (*Sparus centro-dontus*): Otoliths of, 54.  
 Sea Scorpion (*Cottus scorpius*): Otoliths of, 55.  
 Sharp-tailed Lumpenus (*Lumpenus lampretiformis*): Otoliths of, 60.  
 Size of Herring at maturity, 299, 332, 336.  
 Solenette (*Solea lutea*): Otoliths of, 75.  
 Spawning of Plaice, 281.  
 — of Plaice: Duration of, in females, 281.  
 — of Lump-sucker, 169, 176.  
 — Period of Plaice, 111, 281.  
 — Periods of Herring, 302.  
 Specific characters of Brassy, 116.  
 — characters of Poor-cod, 116.  
 — characters of Norway Pout, 116.  
 Spent Herring: Nutritive value of, 103.  
 Sprat (*Clupea sprattus*): External differences from Herring, 167.  
 — Notes on natural history of, 165.  
 — Otoliths of, 78.  
 — Fishery in Tay, 1905-6, 159.  
 — Fishery in Tay: Fish caught in, 160.  
*Stephos scotti*, 278.  
 Streaked Gurnard (*Trigla lineata*): Otoliths of, 56.  
 Striped Wrasse (*Labrus mixtus*): Otoliths of, 61.
- Tachidius discipes*, 278.  
 — *littoralis*, 278.  
 Tay: Sprat fishery of, 159.  
 Teleostean fishes: Otoliths of, 48.  
 Temperature: Influence of, on growth of fishes, 182.  
 — Relation of, to embryonic development of Herring, 303.  
 — Relation of, to growth of Haddock, 306.  
 — Relation of, to growth of Whiting, 306.  
 — Relation of, to migration of Grey Gurnard, 236.  
 — Relation of, to spawning periods of Herring, 303.  
 Thick-lipped Grey Mullet (*Mugil chelo*): Otoliths of, 60.  
 Three-bearded Rockling (*Onos tridactylus*): Otoliths of, 67.  
 Trawling investigations, 17.  
 — investigations in Aberdeen Bay, 25.  
 — investigations in Moray Firth, 18, 27, 31, 34.  
 Trout, Brown (*Salmo fario*): Otoliths of, 76.  
 Turbot (*Bothus maximus*): Age at maturity, 203.  
 — Growth of, 199.  
 — Otoliths of, 70.
- VARIEGATED Sole (*Solea variegata*): Otoliths of, 75.  
 Viviparous Blenny (*Enchelyopus viviparus*): Otoliths of, 60.
- Westcoodina minuta*, 278.  
 Whiting (*Gadus merlangus*): Otoliths of, 65.  
 — Growth of, 229.  
 Witch (*Pleuronectes cynoglossus*): Otoliths of, 74.  
 Worm Pipe-fish (*Nerophis lumbriciformis*): Otoliths of, 79.  
*Zaus spinatus*, 278.







**TWENTY-FIFTH  
ANNUAL REPORT**  
**OF THE**  
**FISHERY BOARD FOR SCOTLAND,**  
**Being for the Year 1906.**

*IN THREE PARTS.*

**PART I.—GENERAL REPORT.**  
**PART II.—REPORT ON SALMON FISHERIES.**  
**PART III.—SCIENTIFIC INVESTIGATIONS.**

---

**PART III.—SCIENTIFIC INVESTIGATIONS.**

---

**Presented to both Houses of Parliament by Command of His Majesty.**

---



**GLASGOW:**  
**PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE**  
**By JAMES HEDDERWICK & SONS LIMITED,**  
**At "THE CITIZEN" PRESS, ST. VINCENT PLACE.**

And to be purchased, either directly or through any bookseller from  
**OLIVER & BOYD, TWEEDDALE COURT, EDINBURGH; or**  
**WYMAN & SONS, LTD., FETTER LANE, E.C. and**  
**32 ABINGDON STREET, WESTMINSTER, S.W. or**  
**E. PONSONBY, 116 GRAFTON STREET, DUBLIN**

1907.

[Cd. 3842.] Price 6s. 6½d.

## CONTENTS.

	PAGE
GENERAL STATEMENT, - - - - -	5
The Hatching and Rearing of Plaice, - - - - -	6
Scientific and Technical Instruction to Fishermen, - - -	7
Investigations on the Herring Fisheries in the Firth of Clyde, -	8
The Food Value of the Herring, - - - - -	10
The Food of the Herring, - - - - -	11
The Spawning, Growth, and Movement of the Mussel, Horse-mussel, and the Spout-fish, - - - - -	12
The Invertebrate Fauna, - - - - -	12

### SCIENTIFIC REPORTS.

I. Report of an Enquiry into the Herring Fisheries of the Firth of Clyde. Part I.—The Statistics of the Fisheries. By Dr. T. Wemyss Fulton, F.R.S.E., Scientific Superintendent. (Plates I.-XII.) - - - - -	13
The Methods of Fishing, - - - - -	15
The Fluctuations from Year to Year, - - - - -	23
The Detailed Statistics :-- - - - -	29
Rothesay District, - - - - -	31
Greenock District, - - - - -	40
Ballantrae District, - - - - -	46
Campbeltown District, - - - - -	62
Inveraray District, - - - - -	76
Campbeltown and Inveraray Districts combined, - - -	92
The Clyde Area, - - - - -	94
The Influence of the Moon on the Catch of Herrings, - - -	98

### TABLES,--

I. Showing the Total Number of Vessels, including their repeated Voyages, entered Inwards from the Fishery, with the Number of Barrels of Herrings Cured on Board ; also the Number of Barrels of Herrings Cured on Shore, and the Total Number Cured, in the Firth of Clyde Districts, in each year 1809-1906, - - - - -	100
II. Showing the Number of Boats, whether decked or undecked, employed in the Firth of Clyde Districts in the Shore-curing Herring and Cod and Ling Fisheries, with the Number of Men and Boys by whom the said Boats were manned, together with the Number of Fish-curers, and the Total Number of Persons employed, in each year 1825-1906, - - -	104

	PAGE
III. Showing, for the Firth of Clyde Districts, the Total Number of Barrels of Herrings Cured, and the Estimated Total of the Number of Barrels of Herrings which were not Cured, in the years 1843-1857, - - - - -	108
IV. Showing the Number of Barrels of Herrings actually Caught within the limits of the various Districts in the Firth of Clyde, irrespective of the place of landing, in the years 1863-1887, - - - - -	109
V. Showing, for the Firth of Clyde Districts, the Total Quantity and Value of Herrings sold Fresh in the years 1884-1888, and the Total Quantity and Value of Herrings landed, whether sold Fresh or Cured, in the years 1889-1906, -	110
VI. Showing the Number of Crans of Herrings landed per Month in the Ballantrae District, 1863-1906, - - - - -	111
VII. Showing the Number of Crans of Herrings landed per Month in the Campbeltown District, 1863-1906, - - - - -	112
VIII. Showing the Number of Crans of Herrings landed per Month in the Inveraray District, 1854-1906, - - - - -	113
IX. Showing the Number of Crans of Herrings landed per Month in the Districts of Inveraray and Campbeltown, 1854-1906, -	114
X. Showing the Number of Crans of Herrings landed per Month in the Greenock District, 1855-1906, - - - - -	115
XI. Showing the Number of Crans of Herrings landed per Month in the Rothesay District, 1854-1906, - - - - -	116
XII. Showing the Number of Crans of Herrings landed per Month for the whole Clyde Area, 1854-1906, - - - - -	117
XIII. Showing the Number of Crans of Herrings landed Yearly at each District in Clyde Area, 1854-1906, - - - - -	118
XIV. Showing the Number of Boats per Month Fishing in the Ballantrae District, 1863-1906, - - - - -	119
XV. Showing the Number of Boats per Month Fishing in the Campbeltown District, 1863-1906, - - - - -	120
XVI. Showing the Number of Boats per Month Fishing in the Inveraray District, 1854-1906, - - - - -	121
XVII. Showing the Number of Boats per Month Fishing in the Inveraray and Campbeltown Districts, 1854-1906, - -	122
XVIII. Showing the Number of Boats per Month Fishing in the Greenock District, 1855-1906, - - - - -	123
XIX. Showing the Number of Boats per Month Fishing in the Rothesay District, 1854-1906, - - - - -	124
XX. Showing the Number of Boats Fishing per Month in the whole Clyde Area, 1854-1906, - - - - -	125

	PAGE
XXI. Showing the Number of Boats Fishing in the whole Clyde Area in each year 1854-1906, . . . . .	126
XXII. Showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1901, . . . . .	127
XXIII. Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854-1906, . . . . .	179
XXIV. Showing the Relation of the Phase of the Moon to the Catch of Herrings in Loch Fyne, 1860-1900, . . . . .	190
II. The Food Value of the Herring. By T. H. Milroy, M.D., B.Sc., F.R.S.E., Professor of Physiology, Queen's College, Belfast. Part II. . . . .	197
III. Some Additional Notes on Copepoda from the Scottish Seas. By Thomas Scott, LL.D., F.L.S., Mem. Soc. Zool. de France. (Plates XIII.-XV.), . . . . .	209
IV. The Spawning, Growth, and Movement of the Mussel ( <i>Mytilus edulis</i> , L.), Horse-Mussel ( <i>Modiolus modiolus</i> , L.), and the Spoutfish ( <i>Solen siliqua</i> , L.). By H. Chas. Williamson, M.A., D.Sc., Marine Laboratory, Aberdeen. (Plates XVI.-XX.), . . . . .	221
The Development of the Reproductive Organs, . . . . .	221
Spawning, . . . . .	228
Growth, . . . . .	233
Movement, . . . . .	242
Structure of Foot, . . . . .	244
Structure of Byssus-Pit, . . . . .	247
The Byssus-Stem, . . . . .	250
Formation of Byssus-Stem, . . . . .	251
Growth of the Spoutfish, . . . . .	251
Literature, . . . . .	252
Explanation of Plates, . . . . .	253
V. Report on the Operations at the Marine Fish Hatchery, Bay of Nigg, Aberdeen, in 1906. By T. Wemyss Fulton, F.R.S.E., Scientific Superintendent, . . . . .	256
VI. Some Observations on the Food of the Herring. By Thomas Scott, LL.D., F.L.S., Mem. Soc. Zool. de France, . . . . .	260

# TWENTY-FIFTH ANNUAL REPORT.

---

TO THE RIGHT HONOURABLE  
JOHN SINCLAIR, M. P.,  
*His Majesty's Secretary for Scotland.*

---

OFFICE OF THE FISHERY BOARD  
FOR SCOTLAND,  
EDINBURGH, 20th November, 1907.

SIR,

In continuation of our Twenty-fifth Annual Report,  
we have the honour to submit—

## PART III.—SCIENTIFIC INVESTIGATIONS.

---

### GENERAL STATEMENT.

This part of the Twenty-fifth Annual Report deals with the scientific investigations in connection with the sea fisheries of Scotland, so far as they have been completed, which have been conducted by the Board in 1906 by means of the Parliamentary Vote granted for the purpose.

The scientific work has, as usual, been carried out under the supervision of Dr. T. Wemyss Fulton, the Scientific Superintendent under the Board, the researches having been undertaken for the most part at the Board's Marine Laboratory at Aberdeen, and in the Firth of Clyde. The hatchery for sea fishes is also situated at Aberdeen, and a statement as to the hatching work done at it during the year will be found below.

As was explained in last year's Report, the investigations into the condition of the fishing-grounds in the Moray Firth and Aberdeen Bay by means of commercial trawlers employed for that purpose were interrupted at the end of the previous year.

In the Firth of Clyde, and more particularly in Loch Fyne, an investigation into the herring fishery and the natural history and migrations of the herring was continued, mainly with the view of throwing light on the decline in the catch of herrings there in recent years, and as to whether any regulations affecting the fishery, either as to the period of fishing or the methods, would be likely to

be generally beneficial. Since the Board have no steamer available for this investigation, the work has been done as far as possible by the employment of fishing-boats and the hire of a small sailing yacht for periodical observations in Loch Fyne.

#### THE HATCHING AND REARING OF PLAICE.

In the Annual Report for last year an account was given of the reconstruction of the hatchery at Bay of Nigg, Aberdeen, with illustrations showing the exterior and interior, the ponds, pumping plant, &c. The adult plaice from which the spawn is obtained are confined in a large tidal pond, where they are kept and fed throughout the year. At the spawning season the eggs are shed into the water of the pond, from which they are collected by means of a large gauze net, and transferred to the hatching apparatus. They are maintained in the hatching apparatus until the young fishes hatch out, the length of this period depending directly upon the temperature of the water. At the commencement of the spawning season, when the temperature of the water is low, the duration of the period of incubation is on the average about three weeks; at the end of the season, when the temperature has risen considerably, it occupies about a fortnight. The larval fishes, after they are hatched, are kept in the apparatus for several days until the yolk-sac is partly absorbed, and they are then placed in the sea.

The success of the hatching operations depends very largely upon an adequate supply of eggs and of pure water throughout the season. In order to obtain a large supply of eggs it is necessary that the number of adult fishes in the pond should be large. Hitherto this has been accomplished tolerably well by the employment of a commercial steam-trawler within the territorial waters, particularly in Aberdeen Bay and the Moray Firth, which was used in connection with the investigations of the grounds above referred to. By an arrangement with the owners, the hatchery attendant accompanied the vessel on such occasions, selecting from the catches such fishes as suited the purpose, and these were kept alive in tubs on board and brought to the hatchery. The plaice required were thus obtained gratis, the remainder of the fish becoming the property of the owners. By the method described the stock of spawners has been maintained from year to year; for, though a large proportion of the fishes of one season survive to the next, there is always a considerable loss which requires to be made good. But, as mentioned in last year's Report, the vessel which was engaged in this work at the end of 1905 was stranded in Aberdeen Bay, and owing to the loss of life occasioned thereby the Board have thought it right to refrain from making use of such vessels in inshore work. In consequence of this, the stock has not been renewed, and the supply of spawn was much less than in former years. Under present circumstances it is not possible to procure supplies of living plaice by means of the ordinary commercial trawlers working in the North Sea. The fish desired are only found in abundance on the inshore grounds, and the cost of obtaining a sufficient number from the offshore would be considerable.

In the season of 1906 the eggs were first observed in the water of the spawning-pond at the beginning of February; the spawning gradually increased towards the end of the month, and was greatest in March and the early part of April, and the last eggs were obtained on 13th May. The total number of eggs collected from the pond was estimated at 7,486,000, as compared with 40,110,000 in the previous year, so that the decrease, for the reason mentioned, was great. The estimated number of fry which were hatched out and put into the sea was 4,406,000, the loss being equivalent to about 41 per cent., which is higher than usual. The principal cause of this was an insufficient supply of pure water towards the end of March, owing to a defect in the filtering arrangements in the rebuilt hatchery, which was afterwards remedied.

The fry were put into the sea in the neighbourhood of Aberdeen in March, April, and May. The number of eggs collected and the number of fry put out at the Bay of Nigg hatchery during the last seven years are as follows:—

Year.	Eggs Collected.	Fry Hatched.
1900 . . .	43,290,000	31,305,000
1901 . . .	63,370,000	51,800,000
1902 . . .	72,410,000	55,700,000
1903 . . .	65,940,000	53,600,000
1904 . . .	39,600,000	34,780,000
1905 . . .	40,110,000	15,790,000
1906 . . .	7,486,000	4,406,000

Owing to the small number of fry available it was not feasible to forward supplies to the northern parts of the coast of Aberdeen, for which the fishermen had petitioned.

It may be mentioned that the expense in connection with the hatching work is comparatively small, since it is carried on in conjunction with the Marine Laboratory without any additional staff. The total expenditure for extra coals, food for the fishes, &c., was estimated at under £80.

During the season the hatchery was visited by delegations of fishermen from the counties of Argyll, Bute, Caithness, and Elgin, under arrangements made with the various County Councils.

#### SCIENTIFIC AND TECHNICAL INSTRUCTION TO FISHERMEN.

By an arrangement originally made with the Technical Committee of the County Council of Aberdeenshire, representative fishermen from various parts of the coast of that county for some years visited the Marine Laboratory in spring to attend demonstrations on the life-history and habits of fishes, such as might be of interest and use to them, and to see the processes of fish-hatching. The arrangement was afterwards extended to other counties owing to the interest taken by the fishermen in the instruction they received, and, as above stated, fishermen from several other counties attended in the spring of last year. Among the subjects taught were the life-history of such fishes as the herring, cod, haddock, and plaice, as well as of the mussel and edible crustacea. The

food, growth, reproduction, &c., of fishes were explained and illustrated by specimens and experiments, and the processes of fertilisation demonstrated, as well as the development of the fishes within the egg.

On this question of the technical and scientific education of fishermen many or most other European countries are in advance of ourselves, special schools being devoted to the work, directly or indirectly under the patronage of the State. It may be mentioned that in the Technical College which it has been decided to establish at Aberdeen provision will be made for the instruction of those connected with the fishing industry in various branches of knowledge bearing upon that industry, such as the preservation of fish and the utilisation of fish-products.

#### INVESTIGATIONS ON THE HERRING FISHERIES IN THE FIRTH OF CLYDE.

During the last few years, as mentioned in previous Annual Reports, an enquiry has been in progress with respect to the herring fisheries in the Firth of Clyde, and especially in Loch Fyne. Those fisheries, like the herring fishery on other parts of the coast, are subject to considerable fluctuations from year to year; and from the circumstance that they are often carried on in comparatively confined and narrow waters, and by several methods of fishing, they have given rise at various times of scarcity to controversies regarding the modes, seasons, or places of fishing. Of late years such complaints have been somewhat common in Loch Fyne, owing to the failure of the fishery in that important loch, the catch having gradually declined from 1897, when the maximum quantity for any year was recorded, to a low point in 1905 and 1906.

The object of the enquiry was to ascertain the nature and extent of the annual fluctuations, and, as far as possible, their causes, and the movements of the shoals of herrings into and out of Loch Fyne. The scheme of investigation included (1) a study of all the statistics of former years that were available; (2) periodical observations on the temperature of the water, and the "plankton" or floating organisms, at different depths; (3) the marking and liberation of herrings when possible, with the view of discovering their migrations; and (4) the examination of large numbers of samples of herrings from various parts of the Clyde, to determine especially the condition of the reproductive organs at different periods and the rapidity with which these organs develop and become fully mature. An investigation of this kind is difficult under the most favourable circumstances and must necessarily cover several successive seasons; and since the range of movement of a shoal of herrings on any part of the coast is at present unknown, it was desired that the investigation might cover at least the whole of the sea area of the Clyde, and in particular the channels by which the herrings enter and leave Loch Fyne. With the means at disposal it was, however, found impossible to extend the periodical observations in this way, which have therefore been limited to Loch Fyne.



In the present volume a report by Dr. Wemyss Fulton will be found dealing with the statistics of the herring fisheries in the Firth of Clyde during past years; and also descriptive of the methods of fishing employed and of the former enquiries made on the subject. The statistics are of two kinds—those published in the annual reports, and those derived from the weekly report books of the various districts. The former go back for nearly a century, to the year 1809, when the Board of British White Herring Fishery was established. They, however, only include the quantities of herrings which were cured, either on shore or on board vessels, for the greater part of the period, and which were landed in the districts. In a series of tables appended to the report these statistics are summarised, both in regard to the herrings which were cured and in regard to the numbers of fishermen and boats which were employed in the various districts of the Clyde. The second class of statistics go back to the year 1854, so that they cover the considerable period of 53 years, and they are of especial value as showing not only the quantity of herrings landed per week, month, and year throughout the period, but also, in the great majority of cases, the places where the fish were mostly caught throughout the season. These statistics are also summarised in a series of tables appended to the report.

With regard first of all to the productiveness of the herring fishery in the Firth of Clyde as a whole, the statistics show that the latter part of the period was more productive than the first part. The aggregate quantity of herrings taken in the 53 years was 3,314,585 crans, or about 11,601,000 cwts., the mean annual quantity being 62,540 crans. In the first twenty-six years, 1854–1879, the quantity landed was 1,254,902 crans, the average per annum being 48,270 crans; whereas in the last twenty-six years, 1881–1906, the gross quantity landed was 1,950,849 crans, the annual mean being 75,030 crans. The excess in the total quantity landed in the latter period was thus 695,947 crans, while the excess in the mean per annum was 26,760 crans.

This increase in the yield of the herring fishery was caused by the increase in the two western districts of Campbeltown and Inveraray or Loch Fyne. Taking them together the mean annual catch in the years 1854–1879 was 29,810 crans, while in the years 1881–1906 it was 56,523 crans, an average annual increase of 26,713 crans. In Loch Fyne the increase was from 22,986 crans in the earlier period to 27,375 crans in the latter period, the mean annual increase being 4389 crans. In the Campbeltown district the mean in the first period was 14,452 crans, and in the last period 26,944 crans, the mean annual increase being 12,492 crans. These figures show that the herring fishery in those districts has on the whole increased in the period. In the other three districts in the Clyde, Rothesay, Greenock, and Ballantrae, on the other hand, the average annual yield has diminished; in the first by 3290 crans, in the second by 2100 crans, and in the third by 2658 crans, in the periods shown in the Tables.

The extent of the annual fluctuations has been considerable. The average annual yield in crans in the various districts and in the Clyde as a whole in ten-year periods is shown as follows:—

	Rothe- say.	Green- ock.	Ballan- trae.	Campbel- town.	Loch Fyne.	Campbel- town and Loch Fyne	Whole Clyde.
1857-66	13,497	*3,170	...	...	...	29,557	46,225
1867-76	12,006	6,472	4,535	8,185	20,255	28,440	51,454
1877-86	4,405	1,634	20,518	29,286	25,679	54,966	81,523
1887-96	7,269	1,587	8,566	26,158	30,943	57,101	74,523
1897-06	9,040	1,689	5,397	26,503	24,889	51,392	67,518

\* Includes figures for Ballantrae which, until 1863, was part of Greenock District.

With regard to the fishing in Loch Fyne the tables and plates show that the good years and the bad years come in groups, and that only on one occasion, 1897, a very good year followed a year in which the catch was below the average. They also show that the recent period of poor fishing was almost exactly paralleled about thirty-two years ago (1872-1874), when a slightly lower point was reached, the curve of fluctuations being closely similar in the two periods.

Tables are also appended to the report showing that the fluctuations from year to year in Loch Fyne are not greater than they are in other areas on the East and West Coasts, where the mean annual yield is about the same.

#### THE FOOD-VALUE OF THE HERRING.

In continuation of his research on the food-value of the Loch Fyne and West Coast herring, the results of which were published in last year's Report, Professor Milroy, of Queen's College, Belfast, contributes to the present Report a paper on the food-value of the East Coast autumn herring. The fish were obtained at Shetland and Fraserburgh, and comprised specimens of the classes known commercially as matties, fulls, large fulls, and spents. The composition of the herring-muscle or flesh is stated in percentages of water, total proteids, coagulable proteids, and fat; the coagulable proteids represent the proteids which are coagulated on boiling the fish, and are important as an indication of the nutritive value. The percentage amount of fat in the fish is in many respects the most valuable indication of the food-value of the herring, but it must not be regarded as the sole one. The herrings richest in fats were the matties and the mattie-fulls—fish in which the reproductive organs were but little developed—while the lowest percentages were found in large spent herrings and large fulls. In spent fish the proportion of fat varied from 6·15 per cent. to 9·32 per cent.; in fulls (in which the reproductive organs are almost or quite developed) the percentage varied from 7·53 to 12·44; in

matties and mattie-fulls it ranged from 10.42 to 16.68 per cent. Taken as a whole, the spent fish have a lower fat-percentage than the corresponding full fish; but it is possible that in some cases the fat-percentage of even spent fish may be higher than that of full fish, owing to the fact that they have been feeding and commenced to store fat again.

Professor Milroy points out in comparing the West Coast and East Coast fish that one is struck with the lower water and the higher proteid and fat-percentages in the latter than in the former; such low fat-percentages as were obtained in some of the winter West Coast herrings were never found in the East Coast autumn herrings. It was found, as a rule, that the fish which possessed the highest percentage of fat in their muscles had the ovaries some time short of full maturity. Usually fish with ovaries of about one-fourth of the weight of the ovary when fully mature contained the highest percentage of fat in their muscles. There is a gradual loss of fat during the later stages of maturation of the ovaries, succeeded by a serious loss after the spawning of the fish. This loss after spawning is evidently a very rapid one, as, although there must be a short period after spawning when the spent fish contains practically the same amount of fat as the full fish, it is rare that one observes this in analyses, and when it is observed it is possibly in some cases due to the fact that the fish is a spent fish in the period of recuperation. It is after spawning that the muscles of the fish lose the largest amount of their stored nutritive material, and it is then that the most undoubted loss of weight occurs, over and above that which can be accounted for by the complete discharge of the ovaries.

#### THE FOOD OF THE HERRING.

Dr. Thomas Scott contributes a paper to the present Report on the food of the herring, as determined by the examination of the stomachs of over five hundred specimens obtained from various districts, including Loch Fyne, Stornoway, Loch Broom, and the Firths of Forth and Clyde. The food observed consisted of post-larval fishes (chiefly herrings, sprats, and sand-eels) to some extent, but mostly of pelagic crustacea. Among the latter the most important as food for the herring appear to be certain Schizopods, Amphipods, and also Copepoda, as *Calanus*. Dr. Scott also examined into the condition known as "gutpoke," which is to be observed in many of the herrings taken in Loch Fyne, especially in the earlier part of the season. In this condition the stomach and intestine are distended with food of a soft and oily nature, such as *Calanus* and post-larval clupeoids, which passes along the gut without being properly digested and causes rapid decomposition to set in.

#### THE SPAWNING, GROWTH, AND MOVEMENT OF THE MUSSEL, HORSE-MUSSEL, AND THE SPOUT-FISH.

On these subjects Dr. H. C. Williamson contributes a paper to this Report, illustrated with a number of figures. The development

and condition of the reproductive organs in the common mussel in various months of the year are described, specimens having been kept in aquaria. At the Bay of Nigg the common mussel was observed to spawn in April and in June, but its spawning time is known to be more extended. Observations were also made on the growth of the mussel and the conditions favourable and unfavourable to growth, as well as on its movements and the anatomy of the byssus and foot.

#### THE INVERTEBRATE FAUNA.

Dr. Scott, in continuation of his work among the smaller marine crustacea which have been obtained in the course of the fishery investigations, has prepared a paper, printed in this Report, on a number of interesting forms. Two of the species which are dealt with were discovered as parasites on the piked dogfish, and are here described for the first time, and another occurs as a commensal in the branchial chamber of large ascidians. The paper is illustrated with three plates.

We have the honour to be,

SIR,

Your most obedient Servants,

ANGUS SUTHERLAND, *Chairman.*

D. CRAWFORD, *Deputy-Chairman.*

D'ARCY W. THOMPSON.

W. R. DUGUID.

L. MILLOY.

D. MEARNS.

H. WATSON

WM. C. ROBERTSON, *Secretary.*

# SCIENTIFIC REPORTS.

## I.—REPORT ON AN ENQUIRY INTO THE HERRING FISHERIES OF THE FIRTH OF CLYDE.

PART I.—THE STATISTICS OF THE FISHERIES. By Dr. T. WEMYSS FULTON, Scientific Superintendent.

(Plates I.—XII.)

### CONTENTS.

	PAGE.
The Methods of Fishing, . . . . .	15
The Fluctuations from Year to Year, . . . . .	23
The Detailed Statistics:— . . . . .	29
Rothesay District, . . . . .	31
Greenock District, . . . . .	40
Ballantrae District, . . . . .	46
Campbeltown District, . . . . .	62
Inveraray District, . . . . .	76
Campbeltown and Inveraray Districts combined, . . . . .	92
The Clyde Area, . . . . .	94
The Influence of the Moon on the Catch of Herrings, . . . . .	98
Tables:—	
I. Showing the Total Number of Vessels, including their repeated Voyages, entered Inwards from the Fishery, with the Number of Barrels of Herrings Cured on Board; also the Number of Barrels of Herrings Cured on Shore, and the Total Number Cured, in the Firth of Clyde Districts, in each year 1800–1906, . . . . .	100
II. Showing the Number of Boats, whether decked or undecked, employed in the Firth of Clyde Districts in the Shore-curing Herring and Coal and Ling Fisheries, with the Number of Men and Boys by whom the said Boats were manned, together with the Number of Fish-curers, and the Total Number of Persons employed in each year 1825–1906, . . . . .	104
III. Showing, for the Firth of Clyde Districts, the Total Number of Barrels of Herrings Cured, and the Estimated Total of the Number of Barrels of Herrings which were not Cured, in the years 1843–1857, . . . . .	108
IV. Showing the Number of Barrels of Herrings actually Caught within the limits of the various Districts in the Firth of Clyde, irrespective of the place of landing, in the years 1863–1887, . . . . .	109
V. Showing, for the Firth of Clyde Districts, the Total Quantity and Value of Herrings sold Fresh in the years 1884–1888, and the Total Quantity and Value of Herrings landed, whether sold Fresh or Cured, in the years 1889–1906, . . . . .	110

## CONTENTS—Continued.

Tables (continued):—	PAGE.
VI. Showing the Number of Crans of Herrings landed per Month in the Ballantrae District, 1863–1906, . . .	111
VII. Showing the Number of Crans of Herrings landed per Month in the Campbeltown District, 1863–1906, . . .	112
VIII. Showing the Number of Crans of Herrings landed per Month in the Inveraray District, 1854–1906, . . .	113
IX. Showing the Number of Crans of Herrings landed per Month in the Districts of Inveraray and Campbeltown, 1854–1906, . . .	114
X. Showing the Number of Crans of Herrings landed per Month in the Greenock District, 1855–1906, . . .	115
XI. Showing the Number of Crans of Herrings landed per Month in the Rothesay District, 1854–1906, . . .	116
XII. Showing the Number of Crans of Herrings landed per Month for the whole Clyde Area, 1854–1906, . . .	117
XIII. Showing the Number of Crans of Herrings landed Yearly at each District in Clyde Area, 1854–1906, . . .	118
XIV. Showing the Number of Boats per Month Fishing in the Ballantrae District, 1863–1906, . . .	119
XV. Showing the Number of Boats per Month Fishing in the Campbeltown District, 1863–1906, . . .	120
XVI. Showing the Number of Boats per Month Fishing in the Inveraray District, 1854–1906, . . .	121
XVII. Showing the Number of Boats per Month Fishing in the Inveraray and Campbeltown Districts, 1854–1906, . . .	122
XVIII. Showing the Number of Boats per Month Fishing in the Greenock District, 1855–1906, . . .	123
XIX. Showing the Number of Boats per Month Fishing in the Rothesay District, 1854–1906, . . .	124
XX. Showing the Number of Boats Fishing per Month in the whole Clyde Area, 1854–1906, . . .	125
XXI. Showing the Number of Boats Fishing in the whole Clyde Area in each Year, 1854–1906, . . .	126
XXII. Showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854–1901, . . .	127
XXIII. Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854–1906, . . .	179
XXIV. Showing the Relation of the Phase of the Moon to the Catch of Herrings in Loch Fyne, 1860–1900, . . .	180

During the last few years, as mentioned in previous Annual Reports, an enquiry has been in progress with respect to the herring fisheries in the Firth of Clyde, and especially in Loch Fyne. Those fisheries, like the herring fishery on other parts of the coast, are subject to considerable fluctuations from year to year; and from the circumstance that they are carried on in comparatively confined and narrow waters and by several methods of fishing, they have given rise at various times of scarcity to controversy concerning usually either the alleged injuriousness of one or other of the modes of capture, or of the fishing being pursued at an improper season at a particular place. Of late years such complaints have been accentuated owing to the failure of the fishing in Loch Fyne. In that important area the yield has declined gradually since 1897, the year in which the maximum quantity recorded was obtained, and a very low point was reached in 1905 and 1906. It will be shown later that the recent diminished productiveness of the herring-fishing in Loch Fyne is an almost exact repetition of what occurred in the period 1868–1874, when even a lower point was reached.

The objects of the enquiry were to ascertain the nature and extent of the fluctuations, and as far as possible their causes; to throw light on the movements of the shoals into and out of the Loch in relation to the

temperature of the water and the amount of food-material present in it; and to determine the extent, places, and seasons of spawning. A scheme was accordingly prepared on which the investigation might proceed, comprising the following :—(1) A study of all the statistics that could be obtained for each of the Clyde fishery districts in former years, going as far back as possible, and of the reports and remarks of the Fishery Officers. (2) Serial observations at intervals on the temperature of the water at different depths. (3) Simultaneous collections of the plankton or floating organisms upon which the herring principally feeds. (4) The marking and liberation of herrings when possible, with the view of ascertaining their movements. (5) The examination of large numbers of herrings periodically from various parts of the Clyde, to determine their feeding, the condition of the reproductive organs as to maturity, and the rapidity with which these organs develop and become fully mature. Special nets have also been used to ascertain the presence of small post-larval and young herrings in the loch, and a research was made by Professor Milroy on the chemical composition of the herrings at different sexual stages, the results of which have already appeared.\*

Since the range of movement of a shoal of herrings at different periods of the year on any part of the coast is unknown, but is believed to be considerable, it was desired that the investigation might cover at least the whole of the sea area of the Clyde. It was obviously of importance that the observations should not be confined to Loch Fyne, but should include the other parts of the Firth, and particularly the channels by which the herrings enter or leave the loch. Comparison of the temperatures and of the plankton at any given time in these areas would be of value. It was, however, found to be impossible to extend the observations in the way indicated, owing to the want of means, and, with the exception noted below, the temperature and plankton observations have been limited to Loch Fyne, a small yacht and boats being hired for the purpose, since no steamer is at the disposal of the Board for such work in the Clyde.

A number of "Stations" were fixed upon at intervals of a few miles, extending from near the mouth of the loch to the neighbourhood of Inveraray. At each Station the temperature of the water was determined at intervals of fifteen fathoms from the surface to the bottom, collections of plankton being also made at the same levels, and the observations were carried on as far as possible in each month throughout the year. In addition to these Captain Alexander, of the superintending Fishery cruiser "*Vigilant*," has taken observations of the temperature of the water (without plankton collections) at the surface, bottom, and one intermediate depth, at various parts of the Firth of Clyde, and these records, with the sanction of the Board, have been placed at disposal.

The various investigations noted above are being continued, and will be reported on later. This part of the report deals with the fluctuations in the yield of the fishery from year to year, and is based upon the statistics which have been collected by the Fishery Officers of the various districts since 1809, but mainly since 1854, as more fully explained below.

#### THE METHODS OF FISHING.

In the Firth of Clyde herrings are captured by three methods of fishing—viz., by drift-nets, seine-nets, and set-nets or ground-nets, of which the two former, and especially the seine-net, are the more impor-

\* See *Twenty-Fourth Annual Report*, Part III., p. 83.

tant. Many fishermen make use of more than one method, and it is common for the seine-net or the drift-net to be used by the same crews at different times according to the judgment of the men as to which is likely to be the more successful. The set-nets, locally but improperly called "trammels," are used principally at Ballantrae and on the Ayrshire coast, and also to a small extent in other localities occasionally, as in the upper reaches of Loch Fyne and the Kyles of Bute. By far the most important method nowadays is the seine, or so-called "trawl," as is shown by the following figures representing the *percentages* of each method of fishing in the Firth of Clyde districts for the year 1906.

Seine-net.				Drift-net.				Set-net.			
Boats.	Men.	Herrings.		Boats.	Men.	Herrings.		Boats.	Men.	Herrings.	
		Cwts.	£			Cwts.	£			Cwts.	£
65	71	73	70	29	25	21·5	25	5	4	5·5	5

The seine-net, which is said to have been first used in Loch Fyne in 1838, and was then improvised from a drift-net, varies from about 150 to 180 yards in length when mounted on the ropes and ready for use. The depth, which is the same throughout, may extend to twenty fathoms, or about forty yards. The meshes of the sides or wings of the net range from 33 to 35 to the yard, but in the central part or bag, where the strain is greatest when the net is hauled, the meshes are somewhat smaller and the twine of greater thickness. The upper rope of the net is corked at intervals, and the sole rope is weighted with leaden sinkers, while the draw-rope at the bottom, by which the net is hauled, may be from 200 to 300 fathoms in length. The seine-net is worked by two boats, or pairs, each of which has four men, so that eight men are employed in connection with each seine. It may be used from the shore or in shallow water like an ordinary ground-seine, a method known as "scringing," and then it is not uncommon for other fishes than herrings to be taken, especially flat fishes on certain grounds. When employed in deep water, as towards the middle of Loch Fyne, the method is known as "ringing" or "circling." The pair of fishing skiffs sail slowly about, never very far apart from one another, looking for the signs of herrings, and when it is decided to shoot the net, the method is as follows. One of the boats is anchored or stationary, and the end of the rope is passed to it from the other boat, which then moves off paying out the net as it goes, and after making a sweep to enclose the fish it returns to the stationary boat. The net is then hauled, care being taken as far as possible to prevent the escape of the herrings downwards by drawing the lower edge of the net under them as the circle is contracted; this edge is then brought on board, and the breadth of the net forms a bag in which the herrings are contained, and from which they are removed to the boat. This method of fishing is sometimes very successful, enormous quantities of fish being occasionally obtained, and it is not uncommon for the net to burst owing to the weight of herrings in it. From the fact that the meshes of the seine are narrow, and the strain upon them when hauling tends to contract them still



further, it sometimes happens that large quantities of small or unsaleable herrings are taken by it. This has been often a subject of complaint by fishermen pursuing other methods, and especially by those using the drift-net.

The drift-net and the set-net act in a different way. They are both gill-nets, the herrings being caught by the gills as they endeavour to pass through the meshes. The drift-net floats in the water, usually at or near the surface, but in Loch Fyne, particularly in the deep upper loch, it may be used by lengthening the buoy ropes in very considerable depths, as far down as sixty fathoms. A "train" or "fleet" of drift-nets may contain from ten to eighteen or more nets, and from the fact that the meshes are larger, running from about 31 to 34 in a yard, and that they stand open, the smaller class of herrings escapes capture, and the size of the herrings caught is more uniform as a rule than with the seine-net. The set-net or ground-net fishes in the same manner as the drift-net, but it is anchored to the bottom. It consists essentially of a strip of drift-net, sixty to eighty meshes deep, the upper rope corked and the lower weighted, so that it stands as a wall of netting rising up from near the bottom. At Ballantrae, where it is chiefly employed, the nets are left in the water over-night, and visited each morning when the weather permits, the herrings being removed and the net again set. It is an effective method on a spawning ground, as Ballantrae Bank.

One of the chief complaints which have been made in the past among the herring fishermen in Loch Fyne refers to the use of the seine-net, or so-called "herring trawl." As already stated, this method is believed to have been introduced about 1838, and it was so successful that within a few years it was very commonly employed, and disputes soon arose between the "trawlers" or seiners and the ordinary drift-net fishermen. The latter alleged that the seine-net was injurious by destroying large quantities of small and immature herrings, by dispersing the "eyes" or shoals of herrings entering Loch Fyne or other narrow waters, and by disturbing and destroying the spawn when used over spawning grounds. This view was supported by the fish-merchants and accepted by the authorities, and in 1851 an Act of Parliament was passed prohibiting the employment of the seine for catching herrings, and recognising the drift-net as the only legal method of capture.\* Great difficulty was found in enforcing this Act, and the seine-net fishermen endeavoured to evade it by all the means in their power. It is clear from the reports of the Fishery Officers, as well as from the official enquiries held later, that seining continued year after year, and was sometimes, indeed, the method by which the greater quantity of herrings was obtained, especially after 1854, when the superintending gunboat was withdrawn owing to the outbreak of war with Russia. It is not surprising that this should have been the case, because again and again it is recorded that while the drifters were obtaining a few hundred herrings the "trawlers" were making large hauls and large profits, their fish sometimes selling (1857) for as much as 28s. 6d. the "long" hundred, of 120, or nearly threepence each. The headquarters of the seiners was Tarbert, though many seines were also employed by Ardrishaig boats, while at Inveraray and in the other parts of the upper loch the drift alone was used. In 1858, and again in 1859, herrings were abundant in Upper Loch Fyne, and on the seiners from the lower loch making their way thither, the drift-net fishermen declared their intention of enforcing the Act against the use of the seine-net, and for this purpose took firearms on board their boats. In 1860 another

\* "An Act to Amend the Acts relating to the British White Herring Fishery," 14 and 15 Vict., c. 26, s. 6.

and more stringent Act was passed against seine-net fishing for herrings,\* and it was enforced as far as possible in the Clyde with the assistance of two gunboats and a staff of police on shore. Seining, however, still went on, especially from Tarbert, and in 1861 a third Act was found to be necessary, which gave power not only to seize and forfeit the seine-nets, but also the boats using them and all the fish they might contain.† Under this Act numerous boats and nets were seized and destroyed. In June, 1861, a fisherman was shot dead by a marine of one of the gunboats engaged in suppressing "trawling," and the Fishery Officer remarks, with reference to this occurrence, that the "fishermen are as determined on trawling as ever, and say they won't give it up, and condemning themselves martyrs, they seem inclined to court martyrdom." Later in the same month he reported that the fishing was being very irregularly conducted, and "although the fishermen state that they see plenty of herrings, they cannot succeed in getting them by drift-nets, and the cruisers' boats harass the trawlers so much that they cannot manage with all their ingenuity to get a haul." In this year very little seining took place, owing to the strength and vigilance of the police force both on sea and shore, and the herrings being abundant and the drifters successful, the fishermen very generally equipped themselves with drift-nets and made use of that method of fishing.

In this year, also, an important Commission was appointed to enquire into the operation of the Acts above referred to. It was composed of Dr. Lyon Playfair, Professor Huxley, and Lieut.-Colonel Maxwell. The Commission examined all the evidence placed before them by the Board of Fishery, and made a personal investigation at Loch Fyne and elsewhere. They found that the yield of the herring fishing in Loch Fyne had increased rather than diminished, when a period of years was considered, notwithstanding the use of the seine-net. "When we look back," they say in their report,‡ "to the records of the fishing in Loch Fyne for the last fifty or sixty years, we find many periods of bad fishing and gloomy depression on the part of the fishermen. In such times of panic they have always been ready to demand legislative protection against other classes of fishermen who were supposed to be interfering with their interests. Thus, in 1836, the Fishery Officer at Loch Fyne, expressing the views of the fishermen there, entreats the Board to protect that loch from ruin by putting down all fishing on the East Coasts of Scotland during the only months when it was productive, because the West Coast fishermen are persuaded that it is the fish of the West Coast which travel to the East Coast to spawn. In fact, every time that there is a panic the reasons assigned for the failure of the herring alter, but are strongly pressed upon the Fishery Board as demands for immediate prohibitory measures." The conclusion of the Commission was that the Acts were quite unnecessary and had been injurious, and that seining, or trawling, for herrings had not diminished the productiveness of the fishery in Loch Fyne, which, on the contrary, had increased. They expressed the opinion that if any legislation had been requisite, it should have been applied to a regulation of the size of the mesh of the seines, which were frequently under the legal standard, and they recommended that the Board of Fisheries should have discretionary powers to prohibit seining for herrings in waters which are too narrow for that method and drift-net fishing being

\* "An Act to Amend the Law relative to the Scottish Herring Fisheries," 23 and 24 Vict., c. 92.

† "An Act to make further Provision for the Regulation of the British White Herring Fishery," 24 and 25 Vict., c. 72.

‡ Report of the Royal Commission on the Operation of the Acts relating to Trawling for Herring on the Coasts of Scotland, 1863.

peaceably carried on together, as in Upper Loch Fyne, above Otter Spit, and in the Kyles of Bute, but these powers should be enforced merely as a matter of police.

Another Royal Commission reported on the subject a few years later. It was composed of Sir James Caird, Professor Huxley, and Mr. G. Shaw-Lefevre. In 1864 they visited the Clyde districts, and in their report\* they said—"We are unable to find any satisfactory proof, in the evidence that has been brought before us, that trawling or circle-net fishing for herrings is, when properly practised, wasteful, or destructive to the brood and spawn of the herring. We are of opinion that it has been and may be a very important means of supplying the market with an abundance of fish, and that, not unfrequently, under circumstances which preclude the capture of herrings by the drift-net fishermen." They pointed out that it was perfectly clear that there are times when the "trawl" will take fish when none can be caught by the drift-net. They declared their opinion that, except in a certain specified locality (Upper Loch Fyne and the Kyles of Bute), no justification whatever existed for the suppression of seine-net fishing for herrings, and they recommended the repeal of the Acts.

It appears that the firm enforcement of the Acts by the Board of Fisheries had brought about a change in the opinions of the fishermen themselves, who, when the drift-net failed to take the herrings they knew to be present in the loch, were prevented from using the seine by which they might have been caught. By an Act passed in 1867† it was made lawful to fish for and take herrings and herring fry at all places on the coasts of Scotland, in any manner of way, and by means of any kind of net having meshes not less than the regulation size of one inch from knot to knot, and the sections in the Acts of 1851, 1860, and 1861 which referred to seine-net fishing for herrings were repealed by the Sea Fisheries Act of 1868.

The restoration of the liberty to use the seine-net was received with great satisfaction by the fishermen generally. They had petitioned that the liberating Act might be hastened, and when intelligence was received in July, 1867, that the Act had received the royal assent there was much rejoicing. The fishermen in Upper Loch Fyne, who had been the most resolute opponents of seining some years before, provided themselves with seine-nets, the fishing was carried on throughout the season almost entirely with such nets, and the Officers reported that there were no complaints of any kind. Except for a short period in September, scarcely any drift-nets were employed, and then mostly because the men were not possessed of seines. They were, moreover, singularly unsuccessful, catching hardly any herrings.

In the season of 1868, however, a change occurred. When the fishing opened, and for a few weeks afterwards, seines alone were used, but then it was found that the drift-net was more successful than the seine, and as the season advanced more and more of the boats put aside the seines and employed drift-nets, which continued the more successful until the end of the year. The reason given by the Fishery Officer was that the herrings kept more than usual out in the deep water, where at that time the seine-net could not be well used. In 1869 the fishing began in the same way and drift-nets gradually replaced the seines. At the end of June 190 boats used seine-nets and 51 drift-nets; by the middle of July, half the

\* Report of the Commissioners appointed to inquire into the Sea Fisheries of the United Kingdom, Vol. I., 1866.

† "An Act to Alter and Amend the Acts relating to the British White Herring Fishery, 1837," 30 and 31 Vict., c. 52.

fleet of boats were using drift-nets; in the middle of August, 285 boats employed drift-nets and 167 seines; by the end of August, 270 boats used drifts and 128 seines. In September, however, heavy catches began to be got by the seines, and for a week or two these nets were chiefly employed. In the seasons of 1870 and 1871 the drift-net was also more successful than the seine, and was much more used.

Fishermen thus became accustomed to use either the seine-net or the drift-net according to which was the more profitable, and harmony prevailed among drifters and seiners so long as herrings were abundant and the fishing successful. The year 1868, the first year since 1851 in which the use of the seine-net was lawful throughout the whole season (although, as just stated, the drift-net was chiefly employed), the yield of the fishery was very high, amounting for Loch Fyne to 39,795 crans, or about 139,280 cwts. From that year to 1873 and 1874 there was a gradual decline in the productiveness of the Loch Fyne herring fishery, and, although, as mentioned above, the drift-net was mostly employed, the seine-net began again to be held responsible for the falling-off in the catch. In 1874 the local Members of Parliament (the Marquis of Lorne for the County of Argyll, Mr C. Dalrymple for the County of Bute, and Sir William J. M. Cuninghame for the Ayr Burghs) undertook an enquiry with a view to ascertain, if possible, what had occasioned the decline. They were attended by the Assistant Inspector of Fisheries (Mr George Reiach), and visited the different localities, collecting the opinions of fishermen and others, and they submitted a report to the Government in the following year.\* They stated that they had examined the antagonistic opinions of the drifters and seiners with great care, and by the light of all the information they could collect, and they were not satisfied that the "trawl-net," though possibly in some cases a destructive and wasteful engine of fishing, was the cause of the evil. The fact could not be explained away that the herrings were at that time disinclined to enter other narrow waters where "trawling" was unknown. Other theories had been suggested to them—such as, that the temperature of the air or water or the amount of rainfall might have affected the fish injuriously, or that the natural food of the herrings might have failed from natural causes—for which theories, however, they thought the evidence was very slight. On the whole they were inclined to the opinion that the fishing had been carried on to too great an extent in the narrow waters, and they recommended that steps should be taken to restrict it to a certain extent. They recommended that the annual close-time from 1st February to 1st June (which was established by the Act 28 and 29 Vic. c. 22, 1865) should be strictly enforced; that the weekly close-time should be extended so that, north of a line drawn from the Mull of Galloway to the Mull of Kintyre, it should begin at 6 p.m. on Saturday and last till midnight on Sunday; that the old regulation against daylight fishing should be renewed and enforced, and that the regulation regarding the dimensions of the mesh of herring nets, which was much neglected, should be enforced.

In 1877 another Commission, consisting of Mr. Frank Buckland, Sir Spencer Walpole, and Mr. Archibald Young, inquired into the subject of the Scottish herring fishing, including the use and effect of the seine-net in Loch Fyne. They came to the same general conclusions as the previous Commissions had done, expressing the opinion that "trawling" involved little, if any, more waste than drift-net fishing. They also agreed that, as a mere matter of police, it was

\* Report by the Commissioners of the Fishery Board for Scotland of their Proceedings in the Year ended 31st December, 1875, p. 3.

desirable to give power to prohibit the use of the seine in Upper Loch Fyne and in other narrow waters less than one mile wide.

By the Sea Fisheries Regulation (Scotland) Act, 1895, power was given to the Fishery Board, by bye-law or bye-laws, to prohibit seine trawling within any area or areas within the limits specified in the sixth section of the Herring Fishery (Scotland) Act, 1889, or in the schedule annexed to it; and a bye-law was passed in 1901 prohibiting the use of the seine-net for herrings on Ballantrae Bank and neighbouring waters, as defined therein.\*

While, as shown above, the seine-net is less effective at some periods than the drift-net, there is no doubt that, taken on the whole, it is the most successful method prosecuted in the Firth of Clyde, and its use has extended considerably in recent years.

The statistics showing the extent to which the various modes of fishing have been practised in the various districts in the Firth of Clyde do not extend very far back, but in the following Table the particulars are given for four of the five districts in the years 1899-1901, and for the five districts, and the whole area, in the years 1902-1906 :—

\* *Twentieth Annual Report*, Part I., p. 258.

District.	SEINE-NET.				DRIFT-NET.				TRAMMEL-NET.			
	Boats.	Men.	Cranes.	£	Boats.	Men.	Cranes.	£	Boats.	Men.	Cranes.	£
<b>1899.</b>												
Ballantrae, -	32	...	977	356	90	...	1,183	1,658	22	...	757	751
Rothsay, -	18	72	2,000	2,223	77	218	1,968	2,187	...	...	...	...
Campbeltown, -	140	630	27,541	33,672	95	320	4,357	6,579	...	...	...	...
Inveraray, -	138	552	23,541	34,074	105	276	7,847	6,875	...	...	...	...
<b>1900.</b>												
Ballantrae, -	42	...	2,286	1,607	78	...	1,363	2,045	28	...	1,824	1,428
Rothsay, -	60	240	1,706	2,100	31	93	569	701	...	...	...	...
Campbeltown, -	200	900	37,652	48,145	64	192	2,905	4,230	...	...	...	...
Inveraray, -	156	624	19,794	30,589	97	239	4,949	5,691	...	...	...	...
<b>1901.</b>												
Ballantrae, -	84	...	7,302	5,522	72	...	1,432	1,465	26	...	1,816	1,850
Rothsay, -	42	140	1,443	1,650	30	68	391	470	...	...	...	...
Campbeltown, -	176	762	29,487	30,518	86	258	1,862	2,782	...	...	...	...
Inveraray, -	164	656	26,350	28,758	96	288	2,567	3,455	...	...	...	...
<b>1902.</b>												
Greenock, -	140	560	1,322	1,396	66	198	554	570	...	...	...	...
Ballantrae, -	56	224	3,469	3,562	73	219	2,916	3,337	49	147	1,652	2,120
Rothsay, -	261	1,015	25,306	13,748	20	60	743	709	...	...	...	...
Campbeltown, -	160	730	36,227	36,393	70	215	1,789	2,475	...	...	...	...
Inveraray, -	172	688	24,279	27,910	124	372	2,060	2,667	...	...	...	...
Totals, -	789	3,207	90,603	83,009	353	1,064	8,062	9,758	49	147	1,652	2,120
<b>1903.</b>												
Greenock, -	...	...	...	...	23	78	435	504	...	...	...	...
Ballantrae, -	50	250	234	193	70	210	1,765	1,845	31	93	245	282
Rothsay, -	253	1,047	25,689	17,314	86	270	2,672	2,236	...	...	...	...
Campbeltown, -	158	732	29,254	36,892	42	136	508	887	...	...	...	...
Inveraray, -	170	680	20,176	28,492	40	130	1,002	1,585	6	12	...	...
Totals, -	631	2,709	75,353	82,891	261	824	6,382	7,057	37	105	245	282
<b>1904.</b>												
Greenock, -	...	...	...	...	18	54	271	424	...	...	...	...
Ballantrae, -	30	150	299	185	66	198	620	946	13	39	529	381
Rothsay, -	210	846	6,920	8,035	30	90	620	923	...	...	...	...
Campbeltown, -	90	427	12,332	16,174	25	87	597	1,140	...	...	...	...
Inveraray, -	156	624	7,383½	14,811	38	122	374½	898	4	8	...	...
Totals, -	486	2,047	26,934½	39,205	177	551	2,482½	4,331	17	47	529	381
<b>1905.</b>												
Greenock, -	68	272	2,283	2,177	60	180	2,275	2,757	...	...	...	...
Ballantrae, -	...	...	...	...	75	225	4,479	4,938	1	3	...	...
Rothsay, -	136	504	1,328	1,189	18	54	410	426	...	...	...	...
Campbeltown, -	88	418	19,355	20,244	20	70	1,790	1,412	2	8	15	20
Inveraray, -	148	592	4,005	6,819	29	93	109	233	3	6	...	...
Totals, -	440	1,786	26,971	30,429	202	622	9,063	9,766	6	17	15	20
<b>1906.</b>												
Greenock, -	100	400	5,611	4,850	64	192	2,076	2,590	...	...	...	...
Ballantrae, -	70	350	10,250	10,495	68	204	2,552	3,678	51	153	2,897	3,227
Rothsay, -	300	1,036	8,830	8,396	100	307	4,879	5,820	...	...	...	...
Campbeltown, -	90	427	9,483	13,774	50	175	1,575	2,773	2	8	12	18
Inveraray, -	130	520	4,640	5,454	28	95	384	350	2	4	...	...
Totals, -	690	2,733	38,814	42,969	310	973	11,466	15,211	55	165	2,909	3,245

THE FLUCTUATIONS FROM YEAR TO YEAR.

The statistics relating to the herring fishery in the Clyde which are available are of two kinds—those which have been printed in the published Annual Reports, and those derived from the books of the Fishery Officers of the various districts. The former go back for a long period, nearly a century, to the year 1809, when the Board of British White Herring Fishery was established. They would, therefore, on this account be very valuable for the purpose of this enquiry if they had contained the information required. Unfortunately, those relating to the quantity of herrings taken or landed deal only with the cured fish, no note having been made until comparatively recent years of the quantity used in a fresh state. In the earlier part of the period it is probable that the proportion of herrings made use of in the non-salted condition, unless quite locally, was small; but in the later part of the period there is no doubt that it was very large, and included the greater portion of the catches. These statistics for each year from 1809 to 1906, and for each district as well as for the whole Clyde area, are given in Table I., p. 100, which shows the number of barrels of herrings cured on board vessels and landed in the district, the number of vessels on which the fish were cured, the number of barrels cured on shore, and the total number cured from both sources. During the period some changes took place as regards the limits of the various districts, as indicated in the Table, and one or two of them include parts of the West Coast not within the Firth of Clyde. Thus, the fishing at Islay from the year 1821 on wards was included in the Campbeltown district, while from 1850 to 1862 the whole of the returns referring to this district were included in the Inveraray district. Another example is the Stranraer district, which from 1821 on includes Dumfries, while in the period 1850–1862 the returns were included in the Greenock district, whereas after 1863 a new district of Ballantrae was formed which corresponded to the previous Stranraer district. It is also to be noted in regard to the barrels of herrings cured on board vessels that the statistics refer only to those which were landed in a district, and do not give any clue to the locality where the herrings were caught. In point of fact, the greater part of such herrings were taken outside the limits of the Firth of Clyde, and especially in the lochs of the West Coast further to the north. Still, with all these limitations the figures are instructive as showing in a broad way the progress of the herring fishery in the Clyde during the greater part of last century.

When the figures are arranged in decennial periods and the annual mean for each taken, the results are as shown in the following Table:—

	Cured on Vessels.	Cured on Shore.	Total Cured.
1809–1818	58,525	6,222	64,747
1819–1828	43,888	4,791	48,679
1829–1838	47,896	5,479	53,375
1839–1848	50,466	8,551	59,017
1849–1858	32,607	24,698	57,305
1859–1868	25,820	49,058	74,878
1869–1878	16,520	40,404	56,924
1879–1888	24,088	88,505	112,593
1889–1898	5,908	22,598	28,578
1899–1906	186	23,707	23,894

These figures show the gradual decline in the quantity cured on vessels and the increase of those cured on shore, but an examination of the Table giving the annual quantities indicates that after 1889 a change took place in the method of the returns, particularly in reference to the quantity given as cured on shore. Thus, in 1889 the quantity so cured was returned as 84,967 barrels, while in the following year it is given as 7,773 barrels. Before that date it seems that the herrings which were not cured were included in the totals—that is to say, the herrings which were sold fresh—but there is nothing to show for how many years previously this method was adopted. From another table (Table III., p. 108) which was published in the Annual Reports for the years 1843 to 1857, and which purported to show the total catch of herrings landed in each district, distinguishing those cured from those which were not cured, it appears that the latter were not included up to 1857, and the evidence of the detailed table indicates that the change was probably made in 1879, the herrings sold fresh being apparently included in the totals in that year and afterwards till 1889. There is, however, no certainty on the point.

The fluctuations in the quantities from year to year are shown in the detailed table (Table I.), and the minimum and maximum numbers of barrels cured in each decade are as follows:—

	Minimum		Total.	Maximum		Total.
	On Vessels.	On Shore.		On Vessels.	On Shore.	
1809–1818	32,261	1915	37,597	81,958	11,940	86,119
1819–1828	26,307	1484	30,044	68,159	10,421	78,581
1829–1838	40,134	1635	42,917	63,376	12,616	67,803
1839–1848	31,899	4441	43,519	72,494	13,630	81,036
1849–1858	19,353	14,960	40,423	51,804	34,367	75,560
1859–1868	16,591	20,848	38,988	41,634	113,955	138,053
1869–1878	6,089	25,294	32,408	36,619	83,794	119,095
1879–1888	2,906	60,477	69,433	46,818	136,057	182,875
1889–1898	—	1,483	1,483	18,166	84,967	103,133
1899–1906	—	21,031	21,031	591	37,360	37,600

The remark made above as to the inclusion of fish sold fresh among the cured herrings in some of the years applies also to this table; it is therefore uncertain how far the figures can be taken as showing the fluctuations in the yield of the fishery.

For the district of Inveraray, which is the chief one to which attention must be directed, a similar summary has been made, showing the average annual number of barrels cured in each decade since 1809, with the maximum and the minimum quantity for each of these periods. The Table is as follows:—

[TABLE.]



Period.	Average Number of Barrels Cured.			Minimum Quantity of Barrels Cured in the Decade.				Maximum Quantity of Barrels Cured in the Decade.			
	On Vessels	On Shore.	Total.	On Vessels	On Shore.	Total.		On Vessels	On Shore.	Total.	
						Year.	Quantity.			Year.	Quantity.
1809-1818	1,959	4,354	6,313	396	1,688	1809	2,084	3,014	9,057	1815	12,034
1819-1828	1,673	1,830	3,503	381	998	1825	1,712	4,311	4,274	1819	6,766
1829-1838	925	3,506	4,431	354	1,453	1831	2,260	1,959	7,444	1838	7,904
1839-1848	3,066	4,568	7,634	303	2,922	1839	3,225	4,845	6,567	1846	10,003
1849-1858	3,930	21,059	24,989	450	11,804	1852	12,254	9,155	31,005	1851	35,325
1859-1868	2,979	27,669	30,648	412	13,593	1864	15,805	8,446	46,715	1862	55,161
1869-1878	7,205	12,859	20,064	1,098	5,785	1874	7,135	18,056	30,838	1869	39,214
1879-1888	15,039	19,328	34,367	10	6,754	1887	15,818	32,888	55,359	1882	94,854
1889-1898	476	4,887	5,363	...	116	1895	116	2,709	30,702	1889	30,702
1899-1906	7	1,648	1,655	...	184	1904	184	38	3,185	1903	3,185

At some of the enquiries which were held in former years as to the prosperity of the herring fishery in the Clyde and Loch Fyne, various statistics were submitted on behalf of the Fishery Board showing the fluctuations in the quantities of herrings taken over considerable periods. Some of them are for different series of years than those referred to above, and as they appear to have been derived from more detailed information than is available in the published Annual Reports, they may be here given. In the report of the Royal Commission on "Trawling" for herrings, published in 1863, it is stated that the general annual average of herrings taken in Loch Fyne for each five years from the year 1834 to 1862 was as follows:—

Years.	Average Quantity Maximum.		Minimum.
	(Barrels).		
1834-1838	...	17,869	—
1839-1843	...	20,119	—
1844-1848	...	15,427	17,610
1849-1853	...	19,149	32,726
1854-1858	...	25,744	31,423
1859-1862	...	42,165	79,893
			20,246

In a more detailed return for the year 1844 to 1862, published in the same report, and also referring to herrings caught in Loch Fyne, the quantity cured is distinguished from the quantity used fresh, and the total for each year is given, as follows:—

Year.	Cured.		Used Fresh.	Total Caught.
1844	...	6,986	6,830	13,816
1845	...	6,923	7,825	14,748
1846	...	7,210	10,400	17,610
1847	...	4,403	11,000	15,403
1848	...	5,060	10,500	15,560
1849	...	3,759	12,115	15,874
1850	...	3,183	11,785	14,968
1851	...	9,884	22,842	32,726
1852	...	3,440	7,190	10,630

Year.			Cured.	Used Fresh.	Total Caught.
1853	...	...	4,399	17,150	21,549
1854	...	...	4,335	12,664	16,999
1855	...	...	7,550	16,811	24,361
1856	...	...	10,553	20,870	31,423
1857	...	...	7,910	18,912	26,822
1858	...	...	11,884	17,384	29,268
1859	...	...	10,046	17,118	27,164
1860	...	...	21,520	19,835	41,355
1861	...	...	8,344	11,902	20,246
1862	...	...	46,859	33,034	79,893

As the Commissioners pointed out, and as the averages above quoted show, the figures indicate a steady increase on the whole in the quantity of herrings taken, with the fluctuations which always occur in fisheries of this nature.

In the report of a later Commission which enquired into the herring fishery in Scotland, and which was published in 1878, will be found statistics showing the actual catch of herrings in Loch Fyne, *i.e.*, above Skipness Point, over a period of fifty years, from 1827 to 1876. The table was prepared by the late Mr. George Reisch, then the Assistant Inspector of Fisheries, from material which I have not been able to discover or trace, but probably from the books of the districts, which do not now exist. Unfortunately, the statistics are not given in detail for each year of the period, but only the average catch, the minimum catch, and the maximum catch, in decades. The Table is as follows:—

Years.	Average No. of Boats.	Average No. of Barrels.	Minimum Catch in Decade. Year.	Minimum Catch in Decade. Barrels.	Maximum Catch in Decade. Year.	Maximum Catch in Decade. Barrels.
1827-1836	300	3,469	1830	1,453	1832	4,898
1837-1846	350	7,388	1839	3,225	1846	9,400*
1847-1856	396	19,949	1852	10,630	1851	32,726
1857-1866	558	33,096	1864	16,131	1862	79,893
1867-1876	479	25,561	1874	6,934	1876	34,471

\* The total for 1846 does not agree with that in the other Table given above.

The statistics showed that there was an increase in every succeeding decade except the last, which included the years of least productiveness, as described later. The Assistant Inspector also gave the catches for each of the ten years of this decade, 1867-1876, in Loch Fyne, above Skipness Point, as follows:—

Year.	Barrels.	Year.	Barrels.
1867	.. 40,964	1872	.. 11,358
1868	.. 46,813	1873	.. 8,166
1869	.. 43,088	1874	.. 6,934
1870	.. 26,716	1875	.. 15,097
1871	.. 22,005	1876	.. 34,471

Besides the statistics relating to the quantity of herrings caught or cured, another series of tables began to be published annually in the Fishery Reports in 1825, which may be cited as indicating the prosperity of the herring fishery in the districts of the Firth of Clyde. They refer to the number of boats and fishermen employed in what were termed the shore-curing herring and cod and ling fisheries, the number of fish-curers,

and the total number of persons employed. The figures for each of the districts, and for the whole of the Clyde area, in each year from 1825 to 1906 are given in Table II., p. 104, and in the following Table the average figures for each decade are represented for the Inveraray district and for the whole of the Clyde districts.

Year.	Inveraray District.				Clyde Districts.			
	Boats.	Men.	Curers.	Total Persons.	Boats.	Men.	Curers.	Total Persons.
1825-34	378	1,120	63	1,598	1,394	4,446	238	7,232
1835-44	755	2,181	36	3,338	2,018	6,145	191	9,472
1845-54	1,241	3,850	65	5,429	2,511	7,710	218	10,980
1855-64	1,052	2,803	84	..	2,180	5,853	186	..
1865-74	1,052	2,352	101	..	2,763	6,114	233	..
1875-84	734	1,691	41	2,190	2,642	5,436	190	8,729
1885-94	481	1,115	20	..	2,219	4,783	157	..
1895-1904	317	874	16	1,241	1,692	3,419	68	8,899
1905	309	868	12	987	1,479	3,053	79	7,858
1906	301	829	20	1,061	1,451	2,930	85	7,968

In considering these statistics, however, it must be borne in mind that the limits of the districts were not always the same throughout the whole period, their extent in some cases being contracted or expanded according to the requirements of the industry, and it appears that such changes were not always explained in the earlier reports. In 1852, for example, there is a distinct fall in the various items of the table for the district of Inveraray, suggesting some re-arrangement of the limits, but the names of the various districts in the tables are unaltered, and no statement bearing upon the point is made in the report for the year in question, so that the matter remains in doubt. But it is stated in the report for 1840 that in that year the district of Fort-William and Tobermory, lying entirely outside the Clyde area, was combined with the district of Inveraray, an arrangement which seems to have lasted till 1869, in which year Fort-William appears as a separate district in the returns. Then in 1850 the district of Campbeltown, which included Islay, was combined with Inveraray district, from which it was again separated in 1863. In the table given above the figures for the last three decades represent the same limits throughout, and it will be seen that in the period there was a gradual but considerable decline in the number of boats and fishermen in the Inveraray district and in the Clyde as a whole. Thus, in the years 1875-1884 the average number of fishermen per annum was 1691, and the average number of boats 734 in the Inveraray district, whereas in the decade 1895-1904 the average number of fishermen was 874 and the average number of boats 317. For the whole of the districts of the Clyde combined the average number of fishermen in the former decade was 5436, while in the latter decade it was 3419, the average number of boats falling from 2642 to 1692. The figures for 1906, both for the Inveraray district and for the whole of the districts, are the lowest recorded.

As explained below, the Inveraray district includes some parts of the coast which are not within the limits of Loch Fyne, or indeed of the Clyde,

being on the west side of Cantyre. It would be of interest to learn the variations within Loch Fyne itself, and there are some statistics which throw light upon the subject. In the report for 1855 a detailed return is given of the number of boats and men belonging to the various villages or creeks, from which it appears that the total number of boats within Loch Fyne was 390, the number of men being 1053, but it includes West Loch Tarbert, where, however, the numbers are very small. Along the coast from Ardlamont to Kilfinan there were 80 men and 30 boats; at Lochgilphead, Ardrishaig, and Inverneil there were 91 boats and 171 men; at East and West Tarbert there were 80 boats and 283 men, making altogether for the Lower Loch, that is, below Otter Spit (and including the few at West Loch Tarbert), a total of 201 boats and 533 men. The totals for Upper Loch Fyne, above Otter Spit, were 189 boats and 520 men, distributed as follows:—East Otter to Newton, 15 boats and 38 men; Leachk, Balure, Strachur, Poll, Cairndhu, and Dunderaan, 37 boats and 104 men; Inveraray, 20 boats and 50 men; Kenmore to Douglas Water, 8 boats and 20 men; Crarae, Sandhole, and Furnace, 36 boats and 104 men; Inverae and Sheep Point, 26 boats and 64 men; Lochgair, 19 boats and 52 men; West Otter and Silvercraigs, 28 boats and 88 men.

No similar return was published till 1886, after which, with the exception of 1887, when it was omitted, it appeared in each of the annual reports. The grouping of the creeks or villages differs, but in the following Table the more important which remained unchanged are given, as well as the totals for the whole coast of Loch Fyne, arranged in means of five-yearly periods:—

Years.	Tarbert.		Ardrishaig.		Lochgilphead		Inveraray.		Lochgair.		Totals.	
	Boats.	Men.	Boats.	Men.	Boats.	Men.	Boats.	Men.	Boats.	Men.	Boats.	Men.
1886	140	350	110	212	56	106	13	10	22	56	491	1,073
1886-90	132	359	89	216	48	107	11	10	19	41	422	1,000
1891-5	119	363	77	221	42	100	11	13	14	34	365	942
1896-1900	86	318	72	197	29	84	10	14	10	29	278	806
1901-5	97	332	70	197	23	79	13	20	9	30	286	831
1906	94	336	68	186	17	70	13	20	7	20	266	787

There has occurred, therefore, a decrease in both boats and men along the shores of Loch Fyne; the decrease in boats, although more pronounced, is less important, since they are now larger than they used to be, and the decrease in men is less marked than on many other parts of the coast of Scotland within the same period. The diminution has taken place more particularly at the smaller creeks, especially in Upper Loch Fyne, where the number of fishermen has been much reduced. Thus, taking the years 1855, 1886, and 1906, and contrasting the figures for the upper with those for the lower loch, we have the following:—

	Upper Loch.		Lower Loch.	
	Boats.	Men.	Boats.	Men.
1855	189	520	201	533
1886	127	281	364	792
1906	74	156	192	631

On the east side of Lower Loch Fyne the decrease has also been pronounced. In 1855, as we have seen, there were 30 boats and 80 men between Ardlamont Point and Kilfinan; in 1832 there were 32 boats and 58 men on the same stretch of coast; while in 1906, along the coast from Ardlamont to Otter Spit, further north, therefore, than Kilfinan, there were only two boats and three fishermen.

Notwithstanding the decrease in the number of boats and fishermen on the shores of Loch Fyne, the quantity of herrings landed has on the whole increased, as is explained below.

#### THE DETAILED STATISTICS, 1854-1906.

The second class of statistics to which reference was formerly made are more detailed, though they do not go back so many years. They consist of the weekly records of the fishings in the various districts compiled at the time by the Fishery Officers in charge, the books containing them having been put at my disposal. The information noted includes the number of boats fishing, the number of crans of herrings landed, and usually the quality of the fish, the prices current for them, the condition of the weather, the chief locality or localities where the fish were caught, and any other circumstances that the Officer thought worth while recording.

Detailed information of this kind extending over a period of years is obviously of value, and these statistics are undoubtedly of value for the purposes of this enquiry. There are, however, some defects which impair their utility. One of the most important is that it is rarely that the weekly returns are recorded throughout the whole year, or over the whole period when herrings are being taken or landed in the district. The entries usually begin with the commencement of the summer fishing, in June or later, the catches for the preceding months being slumped together as a "total for the year up to date." In many cases this omission to specify the catches as they occur is of little importance, the quantities being small. But in other instances the quantity slumped bears a considerable proportion to the whole, and may even form the bulk of the yield for the year. This happens often in the records for the Ballantrae district, where the yield of the winter and spring fishings, as a rule by far the most important, may be merely totalled at the beginning of the summer fishing. The same method is often a marked defect in the records for Campbeltown district, as much as 12,000 crans being slumped in this way for the spring and early summer; and it is in this district that detailed information throughout the year, and particularly at the period of the season in question, is most to be desired. In the Loch Fyne district the influence of this process of slumping is not so great, but it is sometimes noteworthy, as in the period 1855-1859, and after 1893; it also exists in all the other districts.

Another defect is that the place of capture or of landing is not always given. Three of the districts include places outwith the Clyde area. Thus Inveraray includes part of the western coast of Argyll; Campbeltown includes Islay and Jura; and Ballantrae includes the Scottish coast of the Solway. The influence on the statistics of the inclusion of the western part of Argyll in the Inveraray district would be small; but such as it is, it has been almost quite eliminated in the compilation of the tables, the particulars necessary to do so being, as a rule, given in the books. The figures may, therefore, be taken as substantially representing the take of herrings in Loch Fyne. In some years Islay was a very important part of the Campbeltown district, large quantities of herrings

being taken there. In nearly all cases they have been discriminated and deducted; in a few instances there is some doubt; but here also the figures substantially represent herrings taken from the waters of the Clyde.

It has not, however, been possible to subtract the herrings taken in the Solway from the totals for the Ballantrae district, the particulars being usually insufficient to allow that to be done. The figures for this district thus include a certain quantity of herrings which were caught outwith the Clyde. The amount of this quantity and its proportion to the whole may be estimated from the particulars which are given for certain years, which are taken at random from the books. Two groups of five years each were taken, and the quantities of herrings (in crans) landed in the district and outside the limits of the Clyde separated as follows:—

Year.	Landed in District.	Landed outside Clyde.	Per-centage.	Year.	Landed in District.	Landed outside Clyde.	Per-centage.
1883	25,001	228	0·9	1897	1,748	250	14·5
1884	18,323	272	1·4	1898	1,316	29	2·2
1885	23,580	345	1·4	1899	2,978	57	1·9
1886	6,885	989	14·3	1900	5,480	26	0·4
1887	11,751	97	0·8	1901	10,537	36	0·3

Thus, in the years 1883–1887, of a gross quantity of 85,540 crans of herrings landed in the Ballantrae district, 1931 crans, or 2·2 per cent, were landed at creeks and villages outwith the Clyde; in the years 1897–1901, of a gross quantity of 22,057 crans landed, 398 crans, or 1·8 per cent., were landed outwith the Clyde. The percentage for the ten years is 2·1, which is small; but the variation, as shown in the table, ranges from 0·3 per cent. to 14·5 per cent., an amount which requires to be taken into account in considering the fluctuations in the district, but which can have but little influence on the figures for the Clyde as a whole. The herrings from the non-Clyde creeks, it may be added (Portpatrick, Portlogan, Drummore, Sandhead, Glenluce), are caught in summer, and mostly in June and July.

Besides this, it would be of importance if the locality where the bulk of the fish were caught, or where the fishing was mainly prosecuted, in each week were always given. In Inveraray district, for example, it is of value to learn whether the herrings were taken for the most part in the upper loch or in the lower loch at any particular period. In the Campbeltown district it is of equal importance to know if they were taken in Kilbrennan Sound or to the south or east of Arran. As a rule this information is afforded more or less clearly in the records, but often it is not, and its absence makes it difficult to follow the movements of the shoals of herrings from one part to another in such districts or years. Nevertheless, the information given on this head will be of importance when the subject of the migrations of the herring is dealt with.

Finally, it is to be noted that the weekly records are not always or necessarily strictly accurate, although they generally are. They are compiled by the Officers from the statements supplied by the fishery correspondents at the various creeks or villages, and from the buying

steamers, by far the greater part of the herrings taken in Loch Fyne and the Clyde generally being carried away directly from the boats on the grounds by steamers which forward them to the Glasgow market. It sometimes happens that corrections require to be made as to the quantities, which is generally done at the end of the month, or at the end of the year, without the record for any particular week being altered. The totals for the districts, as given in the appended tables, do not, therefore, always correspond with the totals in the annual reports, for the reason just mentioned, and because the herrings landed in certain districts but taken outside the Clyde area are deducted.

The tables give the weekly catches of herrings in each of the districts of the Clyde, as well as the number of boats fishing, and in other tables a summary of this information is given under each month of the year. These particulars are also represented in a series of Plates showing the monthly and annual quantities for the various districts and for the whole Clyde. With regard to the number of boats fishing, it is necessary to say that the number for any given week usually represents the maximum number employed in the fishing on any one night in that week; it does not represent the number of "voyages" or "trips" for the week—that information not being given in the reports; and the number for any month is the total for the weeks in it. The information regarding the boats, therefore, while useful as showing in a general way the relation between the extent of the fishing and the quantity of herrings taken, cannot be made use of in a precise manner to show that relationship.

#### *Rothsay District.*

The limits of this district lie entirely within the area of the Clyde, embracing the coast from Roseneath Point, in Dumbartonshire, to Ardlamont Point, in Argyll. It thus includes the Kyles of Bute and a number of lochs, as Loch Long, Loch Goil, Holy Loch, Loch Striven, and Loch Riddon. It also includes the islands of Bute, Arran, the Cumbraes, and Inchmarnock. In 1906 the number of fishing boats pertaining to the district was 176, and the number of resident fishermen and boys was 247. The herring fishing is pursued usually between Bute, Arran, and Cantyre, in the Kyles of Bute, and Loch Fyne.

The weekly records go back to the year 1854, and they will be found detailed, as regards the quantity of herrings landed and the average number of boats fishing, in Table XXII., p. 127, while the quantities of herrings landed in each month of the various years, as far as they can be ascertained from the books, are given in Table XI., p. 116, and the total quantity for each year in Table XIII.

The gross quantity of herrings landed in the district in the 53 years 1854–1906 amounted to 469,848 crans, or about 1,644,400 cwts.; the fluctuations in the annual quantities varied from 480 crans in 1854 to 38,436 crans in 1865, the annual mean or average for the whole period being 8865 crans. In this district the quantity of herrings landed has, on the whole, diminished. In the first twenty-six years, 1854–1879, the annual average was 10,510 crans, while in the last twenty-six years, 1881–1906, the annual average amounted to 7220 crans, an annual average decrease of 3,290 crans. When the figures are grouped into ten-yearly periods, the average annual quantities for each decade are as follows:—

1854–56	1857–66	1867–76	1877–86	1887–96	1897–1906
2,552	13,497	12,006	4,405	7,269	9,040

When arranged in periods of five years, the annual averages for each period are these :—

	Crans.		Crans.
1854-56 ..	2,552	1882-86 ..	4,653
1857-61 ..	3,600	1887-91 ..	11,881
1862-66 .	23,395	1892-96 ..	2,658
1867-71 ..	19,484	1897-1901	2,601
1872-76 ..	4,529	1902-06 ..	15,479
1877-81 ..	4,158		

When the annual quantities are represented in the form of a graphic diagram (Plate II.), the outstanding feature is the very high catches from 1864 to 1871, and especially from 1864 to 1867. In the eight years the total quantity landed was 207,470 crans, or almost half of the gross quantity landed in the fifty-three years, and the annual average was 25,934 crans. In the four years 1864-1867 the annual average was 34,721 crans.

The information contained in the officers' books in regard to the place of fishing in these years enables us to trace the movements of the shoals, and it may be said that the success of the fishing in all the successful years in this district depends on the shoals penetrating the Kyles of Bute from the south and entering Loch Riddon, and also the other lochs of the district, viz., Loch Striven, Loch Long, Loch Goil, and the Holy Loch.

The fishing in the district begins late, usually not till the end of June or in July, and in some years not till August. In the early months after it has begun, the herrings are chiefly taken on the coast of Arran, on the west side of Bute, in Kilbrennan Sound, and at the mouth of Loch Fyne, few or none being caught in the Kyles of Bute or the lochs of the district. In many years this is the state of affairs throughout the whole season. Thus, if we summarise the information for the successful years above mentioned, and for a year or two before, we have the following :—In 1862 the fishing began in the week ending 5th July, on the coast of Arran and the west side of Bute, trials in the Kyles and in Loch Long being rewarded with only a few dozen herrings. During the whole season the fishing was in these waters, in Kilbrennan Sound, and in Loch Fyne, only a few herrings being taken in the Kyles, the largest quantity being got in November and December, and the total for the two months was only 109 crans, a few of which were obtained in Loch Riddon.

In 1863 the fishing began on the week ended 27th June, on the Arran coast, Kilbrennan Sound, and the west side of Bute ; there was no fishing in the Kyles, but the fishermen reported that a considerable quantity of small herrings were to be seen about the Kyles. In July the grounds were the same, but they now included the area about Ardlamont Point and also Loch Fyne. There is no record of the place of fishing in August ; in September it was mostly about Ardlamont ; in October it extended up the Kyles to Tighnabruaich ; in November it was the same ; in the early part of December the fishing was between Tighnabruaich and Loch Riddon, and as the month advanced it was concentrated in Loch Riddon and the adjacent part of the Kyles, and the catches were good. The particulars as to the weekly catches and the number of boats fishing will be found in the table (p. 127). The totals for the last four months, in crans, were—September, 107 ; October, 231 ; November, 592 ; December, 2832, the total for the year being 4642 crans. At the end of December the herrings became scarce and the fishing ceased.



In 1864 the fishing began early in July, and was carried on at Arran and the west side of Bute during that month, none being got in the Kyles. There is no information for August and September, but at the end of the latter month the fishing was chiefly at Ardlamont Point and the west side of Bute, the catch up to the 24th September being 2240 crans. The shoals were now reported to be settling into the Kyles, and in October the fishing was carried on there and in Loch Riddon. In November great takes were got in these places; about the middle of the month the herrings were also found in Loch Striven, and at the end of the month they were very abundant there, and also at Port Bannatyne. The same conditions prevailed in December, the best fishing being in Loch Riddon and Loch Striven. Towards the end of the month the fishing fell off and the boats left, the fishing not being continued into January; and it is noteworthy that no mention is made this year of any herrings being taken in the more northern lochs of the district, as Lochs Long and Gail. In the various weeks in November and December the catches (in crans) were as follows:—

November.	December.
5,200	2,330
2,500	4,364
2,600	5,500
2,280	1,823
<hr/>	<hr/>
12,580	2,614
	<hr/>
	16,631

As was customary, the successful fishing attracted boats from all parts of the Clyde, as many as 400 being sometimes engaged, and it is to be noted that at this time the seine-net, or "trawl," was not employed, but only the drift-net.

In 1865 the fishing began at the end of June, and only ten crans were taken up to 1st July. In July a few were got in Loch Riddon, but the grounds frequented were mostly Arran, Kilbrennan Sound, the west side of Bute, and Ardlamont. In August full information is not given, but it is noted that the boats were successful at Arran and Bute. About the middle of September the herrings set into the Kyles of Bute—a few weeks earlier than in the previous year—and at the beginning of October the boats were fishing as far up as Loch Riddon, but this fishing fell off, and from about the 21st October to 9th November most of the herrings were taken about Ardlamont and on the west side of Bute. At the latter date the fishing began again in the Kyles and Loch Riddon and so continued. By the end of the month herrings were taken in abundance in Loch Striven and at Port Bannatyne Bay, and in the beginning of December the fishing was more successful at these places than in Loch Riddon or the Kyles; the oldest fisherman at Port Bannatyne, it was said, did not remember such a fishing there. But on the 10th December the herrings left Loch Striven and Port Bannatyne Bay and the fishing was carried on at Loch Riddon and in the Kyles with great success, the enormous quantity of 6400 crans being taken in the last week of the year. On this occasion the fishing was carried on till the end of January in these places, but it fell off towards the end of the month, and all the boats had left by the beginning of February. The total for the year was the largest on record for the district, amounting to 38,436 crans. The weekly catches for the last five months of the year, and for January 1866, and the totals for each month, were as follows:—

August.	September.	October.	November.	December.	January.
650	218	1,650	15	3,800	2,000
800	220	3,000	400	2,700	2,500
750	1,720	2,000	2,400	3,600	2,000
1,600	600	300	2,084	6,400	660
742	..	..	2,087	..	300
4,542	2,758	6,950	6,986	16,500	7,460

In this year again only the drift-net was employed, the use of the seine being still illegal and the prohibition enforced, and no mention is made of a fishing in the more northern lochs.

In 1866 the summer fishing began in the week ended 7th July, and during that month the grounds were the usual ones—Arran, Kilbrennan Sound, and the west side of Bute. This was the case also in August, but towards the end of the month herrings were taken also at Ardlamont and in Loch Fyne. In September the fishing was still at the north end of Arran and Loch Fyne, but a little before the middle of the month the best catches were got at Ardlamont, though the gross quantity was not large. For a day or two about the 9th October a good fishing was got in the Kyles, but it fell away until the week ending the 27th, when the fishing was chiefly in the Kyles and Loch Riddon, and 920 crans were caught. In the early weeks of November the fishing was continued with much success at these places, and also in Loch Striven and Port Bannatyne Bay. In the week ended 24th November it is noted, for the first time, that a fishing had started in Loch Long, where 50 boats were engaged; but this fell off in the succeeding week. Early in December the fishing declined also in the Kyles and Loch Riddon, and it was believed the shoal had for the most part left, the weekly total going down to a few hundred crans. But in the week ended 29th December it is noted that a new shoal had entered the Kyles of Bute, and the fishing went on with success to the end of January, 1867, in Loch Riddon and the Kyles. Towards the end of January the shoals left Loch Riddon and the fishing was chiefly in the neighbourhood of Ardlamont and Kames Bay, at the entrance to the Kyles, and at Tighnabruaich, where the heaviest catches were obtained. Until the end of December a few boats continued to prosecute the fishing in Loch Long, but with little success, getting a few hundred herrings. The details for the weeks are as follows:—

August.	September.	October.	November.	December.	January.
452	372	120	3,500	500	2,300
790	100	1,962	3,800	900	2,000
566	..	96	4,999	800	2,860
341	107	920	1,800	3,500	3,800
306	..	..	1,800	..	1,800
2,455	579	3,098	15,699	5,700	12,760

The aggregate catch for the year was 35,297 crans, and only the drift-net was employed throughout the season.

In 1867 the fishing began unusually late, the first entry in the records being for the week ended 3rd August, when 70 crans were caught at Arran and Inchmarnock. During the rest of the month and in September it continued light and in the same waters. In October the grounds mentioned are the west side of Bute and Loch Long, where a few herrings were caught. On 19th October it was reported that some good takes were got with the seine in Loch Long, that there had been no fishing in the Kyles of Bute, but that a shoal was reported within Ardlamont Point. On 22nd October fishing set in in the Kyles, seines as well as drift-nets being now used. In November the fishing continued in Loch Riddon and the Kyles, and there was also a slight fishing in Loch Long and Loch Goil, which is a branch of Loch Long; but in the Kyles and Loch Riddon it fell off, and many of the boats left for Gareloch (in the Greenock district), where a good fishing was reported. In the first part of December the fishing continued to be poor in the Kyles and Loch Riddon, and was entirely by seines, and it fell off in Loch Long and the Gareloch, but a little was still done in Loch Goil. But about the middle of December the fishing began again to be very successful in the Kyles and in Loch Riddon, and large takes were obtained, only by seines, and this condition continued till the middle of January, 1868, when it fell off, the fishing closing at the end of the month, chiefly about Ardlamont and the west side of Bute. The catches in the various weeks were as follows:—

August.	September.	October.	November.	December.	January.
70	43	40	1,340	550	60
67	37	14	400	610	1,071
103	50	120	607	3,100	454
85	90	340	730	3,060	1,290
75	..	4,500	..	..	60
400	220	5,014	3,077	7,320	2,935

The total for the year was 28,791 crans.

In 1868 the fishing began in the week ended 25th July, at Arran, Inchmarnock, and between Bute and Arran. In August and September the grounds were the same; but from the beginning of September there was a fairly good fishing in Loch Long, where 18 boats were engaged. In October only a few hundreds of herrings were got in trials in the Kyles, better catches being taken near Ardlamont. In this month and in November many of the boats left for Greenock and the Gareloch, but a slight fishing was still carried on in Loch Long, and a few herrings were caught in the Kyles and Loch Riddon, but there was no appearance of a shoal. In December very little fishing was done in the district till about the middle of the month, when fair takes began to be got in the Kyles of Bute (part not specified), and in Loch Long and Loch Goil. In the week ended 19th December it is stated that the fishermen reported there was a great shoal of herrings in Loch Long, which they supposed to have come from the Clyde, that is to say, the Greenock district. The fishing in the Kyles fell away towards the end of

December, ceasing there altogether on the 28th, when 40 crans were taken. It continued, however, in Loch Long with seines and drift-nets till 20th January, and in Loch Goil till the end of the month. In this year, therefore, the shoals did not penetrate the Kyles of Bute to any great extent, while, on the other hand, they were present in the northern lochs in greater force than in the previous years. The quantities caught in the various weeks were as follows:—

August.	September.	October.	November.	December.	January.
182	320	180	..	80	1,500
53	130	200	..	..	1,200
57	60	400	160	1,350	400
13	50	150	68	1,904	250
..	..	..	..	1,300	..
305	560	930	288	4,634	3,350

The total for the year was only 9712 crans.

In 1869 there was a revival of the prosperous fishing. It began on 17th July, and up to the end of October it was carried on in the usual waters, the north of Arran, and at Ardlamont and the mouth of Loch Fyne; trials in the Kyles and Loch Long gave but poor results, and it was stated that the shoals had moved up into the Clyde. At the end of October fishing started in the Kyles and in Loch Long, and in November it improved at both places, and also in Loch Goil. At the beginning of December about 450 boats were fishing in the Kyles with both seines and drifts, the former being most successful, while about 50 boats were fishing in Loch Goil with drift-nets. This condition continued till the end of December, the bulk of the herrings being taken in the Kyles, the fishing in the northern lochs falling away; and in January the fishing went on in the Kyles till the end of the month. The number of crans taken in the various weeks are as follows:—

August.	September.	October.	November.	December.	January.
..	483	740	280	3,200	700
117	287	2,040	1,200	3,750	900
120	680	390	1,800	1,400	400
700	70	260	2,300	250	450
..	45	..	..	225	..
937	1,565	3,430	5,580	8,825	2,450

The total catch for the year was 24,093 crans.

In 1870 the fishing began in the week ended July 9th; trials made in this month and in the summer in the Kyles and lochs gave very poor results, most of the herrings landed being taken about the north of Arran. In October the fishing was chiefly about Ardlamont and the entrance to

the Kyles, and this was also the case in November until the end of the month, when a fishing started in Loch Striven and Loch Long. At the beginning of December the fishing was chiefly in Loch Long, Loch Goil, and Holy Loch, but good catches were also got on the west side of Bute. The total for the first week was 4500 crans; and it would appear that on this occasion the herrings did not make their way up the Kyles, but moved up the east side of Bute. In the second week of December the fishing in Loch Long was fair but partial, but heavy takes were got by seiners on the west side of Bute, one Tarbert crew getting a haul of about 500 crans, for which they received several hundred pounds. Towards the end of the month the fishing was mostly in Loch Long, Loch Striven, and in the channel between Dunoon and Wemyss Bay, and in January in Loch Long and Loch Goil, from which the herrings moved out in the latter part of the month, and the fishing came to a stop. The catches in the various months were as follows:—

July.	August.	September.	October.	November.	December.	January.
1,370	1,090	1,133	1,050	2,141	9,000	4,260

In 1871 the fishing began in the week ended 24th June, and in this year the herrings were taken up to the end of July chiefly in the Kyles of Bute, Loch Striven, and Loch Long; also on the west side of Bute. From this time to near the end of November the fishing was chiefly in Kilbrennan Sound and between Arran and Skipness Point, trials made in the Kyles and lochs giving no results. But in the week ending 25th November a fishing sprang up in Loch Goil and Loch Long, the catch for the week amounting to 1200 crans. In the early part of December the fishing continued to be good in these lochs, and also in mid-channel between Dunoon and Wemyss Bay; but though it kept up fairly in Loch Long to the end of the month, most of the boats went off to Wemyss Bay and Greenock. In January, 1872, herrings were still obtained in Loch Long and Loch Goil, but the weather greatly interfered with the operations, and none were caught after the 13th. In this year again the herrings appear to have made their way to the northern lochs of the district by the east side of Bute. The quantity taken in each of the months was as follows:—

June.	July.	August.	September.	October.	November.	December.	January.
800	455	1,315	525	38	4,696	4,500	180

The total for the year was 16,589 crans.

In 1872, when the fishing began in the week ended 27th July, very few herrings were got in the Kyles of Bute, but from October on to the early part of January the chief fishing was in Loch Long and Loch Goil, some large takes being made with the seine—one seining crew at the beginning of December realising £420 for two nights' work in Loch Long. The shoals left these lochs about the middle of January. The total catch for the year was only 9135 crans, and the monthly takes as follows:—

July.	August.	September.	October.	November.	December.	January.
80	740	720	880	4,290	2,245	170

In 1873 the herrings did not visit the Kyles of Bute or the northern lochs, and the total for the year was only 3151 crans, less than was sometimes taken in a single week, which were chiefly obtained at Arran.

The last herrings landed in the district were five crans in the early part of November, which were caught off the Ayrshire coast. The fishermen, it is noted, did not remember any season when the herrings were so scarce in the later months of the year. The monthly totals were as follows:—

June.	July.	August.	September.	October.	November.	December.
50	704	368	1,218	626	15	—

From 1873 to 1887 the annual yield of the district was small, and few or no herrings were taken in the Kyles or the lochs. In that period the best year was 1880, when 8829 crans were caught, and the records show that the great bulk of the fish was obtained at Loch Ranza, Arran, and in Kilbrennan Sound. Still a fair, though not large, fishing was carried on by the smaller boats in the Kyles of Bute and Lochs Long, Goil, Striven, and Riddon at the end of June and in July, and some herrings were taken in Loch Striven in October.

From 1887 to 1891 the yield was higher, especially in 1890, when the aggregate was 18,749 crans, the annual average for the five years being 11,881 crans. In 1887 the fishing began in the week ended 9th July, in the Sound of Kilbreunan, off Ardlamont, and in the Kyles, as well as Lochs Striven and Riddon, and fishing was also prosecuted in Loch Long. But throughout the year the principal fishing area was in the neighbourhood of Skipness, between Arran and Bute, and in Kilbrennan Sound, practically all the herrings got in the later months of the year being obtained about Machrie Bay, Arran. The total for the year was 10,376 crans.

In 1888, when the total was 9919 crans, the fishing began favourably in the week ended 30th June, in Lochs Long, Goil, and Striven. The Officer noted that the fishing in Loch Long was the most successful for many years there, and that there was every indication of a large shoal of herrings having passed up the Clyde. In the week ended 14th July it is stated that the fishing in the lochs had been very successful, the catch in Loch Striven being 331 crans, and in Loch Long 400 crans, all large, fine fish. The fishing in Loch Riddon and the Kyles was also successful. In August, though herrings were still being got in the lochs and in the Kyles, the fishing was chiefly in Kilbrennan Sound; a few were obtained in Loch Striven in September. But after this the herrings were caught in Kilbrennan Sound, Machrie Bay, and off Skipness and Ardlamont till the season closed early in December. In 1889, the fishing began at the end of June in Lochs Striven, Long, and Goil, and also on the west side of Bute, and off Garroch Head. The loch fishing was slight in July, but early in August it was successful in Loch Striven and the neighbourhood of Rothesay, and there was a fair fishing in the Kyles and Loch Riddon. After this the fishing in Lochs Long and Goil fell off, and though herrings continued to be taken in Loch Striven and the Kyles, the chief fishing was to the south off Ardlamont and then off Skipness. The total for this year was 8849 crans.

In 1890, when the aggregate totalled 18,749 crans, the fishing again began in the week ended 21st June, in Lochs Striven, Long, and Goil; it continued there and also in the Kyles and at Arran during July, falling away in the lochs as the month advanced. In August the chief fishing place was off Ardlamont, where the great bulk of the fish in this month were obtained, but herrings were also taken in the Kyles of Bute, Loch Riddon, and at Arran. In September the most productive area was also at Ardlamont, but herrings were also taken in the Kyles, Loch Riddon,

and the neighbourhood of Port Bannatyne. During the rest of the year most of the herrings landed were caught at Ardlamont, Skipness, and on the Arran coast, the season closing in the early part of December. The catch in each month was as follows:—

July.	August.	September.	October.	November.	December.
6,002	8,612	2,548	515	593	145

In 1891, when the aggregate catch was 11,513 crans, the fishing opened in the week ending 27th June, the Officer reporting that there had not been such a successful fishing in the Kyles of Bute and Loch Riddon for the previous twenty years as in the past week, and conjecturing that the shoal which usually visits Loch Striven had this year entered the Kyles. The catches in Loch Long and Loch Goil were also very good. But in the following week the fishing declined in these localities, and the fishermen turned their attention to the Arran waters, where, until the end of September, most of the herrings were taken, but a small fishing went on in the Kyles and Loch Riddon. In October the most productive localities were off Skipness Point and the Sound of Kilbreunan, and in November also Ardlamont and Kames Bay.

As may be seen from the tables, the yield from 1892 to 1901, inclusive, was very small, the annual average for the ten years being 2629 crans, but in 1902 and 1903 there were again great takes of herrings in the district.

In 1901, when only 1825 crans were landed, the catches were made chiefly about Skipness Point, Inchmarnock, and Ardlamont, it being stated that the fishing in the lochs was a complete failure, and the last herrings of the season were landed on the 12th October.

In 1902, when 26,049 crans were landed, the information as to the locality of fishing is, unfortunately, defective for the earlier part of the season, but it appears that in August some herrings were obtained in Loch Striven and in the Kyles. At the end of October the bulk of the herrings were taken off Garroch Head, at Inchmarnock, and in the Kyles of Bute. In the week ending 8th November all the herrings landed, 2808 crans, were caught in the Kyles of Bute, where fishermen reported a "fine appearance" of herrings. In the succeeding weeks they were still plentiful in the Kyles and in Loch Riddon, and a very successful fishing was carried on there until the end of January and into the first week of February, when it ceased. In one week in November the 216 boats fishing caught 5219 crans, the totals for the various months of the season being as follows:—

July.	August.	September.	October.	November.	December.	January.
624	560	224	2,705	12,344	9,147	7,131

In 1903 the catch was still greater, viz., 28,361 crans. Up to the end of August the takes were light, the herrings being got chiefly about Skipness Point, and very little was got in Lochs Riddon and Striven. At the beginning of September a large shoal appeared between Inchmarnock and Ardlamont Point, apparently making for the Kyles of Bute, and till the end of September large hauls were got there and between Inchmarnock and Garroch Head. The shoals did not enter the Kyles till about the middle of October, their movements being described as very erratic, a circumstance which was attributed by some to the use of seines in these narrow waters. From the latter part of October and in November the catches fell off, especially those of the seiners, the herrings, though known

to be abundant, not rising to the surface, which was ascribed to the prevalent wet weather. Ground-nets, or so-called "trammels," were largely used, with success, as well as drift-nets. In the week ended 12th December a good fishing was got (2607 crans) by the three modes in the Kyles and Loch Riddon. In the succeeding weeks seines were most successful, but as the market was glutted and prices fell the fishing became slack, and the last herrings were taken on 26th December. It appears, however, that the fishing was resumed in January, because the first entry in the records for the next year is 2843 crans for the winter fishing, and though no details are given as to the weekly catches or the place of fishing, it may be surmised to represent the fishing in January in the Kyles and probably Loch Riddon. The quantities for the various months were as follows:—

July.	August.	September.	October.	November.	December.	January (?)
413	351	3,327	2,944	2,717	10,897	2,843

In 1902–1903 there was thus a repetition of what took place 36 years before, but in the later case the shoals of herrings did not apparently penetrate to Loch Striven and the northern lochs, as mention is not made of any fishing north of Loch Riddon. The fishing, moreover, in 1904 fell to 7540 crans, and to 1738 crans in 1905. In 1904, herrings entered the Kyles at the end of September, and a fair fishing was got between Ardlamont Point and Tighnabruaich, and in the first fortnight of October in Loch Riddon also. The herrings disappeared after this in the Kyles until December, when a few hundred crans were caught. In 1905 the Officer reported unusual quantities of mackerel as being caught in July and August especially, and practically no fishing took place in the Kyles.

In 1906 the aggregate catch was again above the average, amounting to 13,709 crans; but in this year the successful fishing was due, not to the herrings having come into the Kyles or the northern lochs, but to their congregation on the east side of Arran, and especially in Brodick Bay and neighbourhood, a position not recorded in any previous year. In August, and still more in September, great catches were made in that locality. In the early part of October the shoal shifted northwards, and in the week ended 13th, 3218 crans were taken in the vicinity of Inchmarnock, at the mouth of the Kyles, to which it was supposed the herrings were moving. Stormy weather followed, and the herrings disappeared, and the quantity taken in the remaining months was very small, and mostly in Loch Striven, but also in Loch Riddon and on the Ayrshire coast. The catches in the various months were as follows:—

June.	July.	August.	September.	October.	November.	December.
133	416	2,754	6,070	3,904	72	197

*Greenock District.*

This district comprises the upper part of the Clyde, including the coast of Dumbartonshire on the north, the coast of Renfrewshire, and the northern part of the coast of Ayrshire as far as, but not including, the port of Ayr. It thus includes the estuary of the Clyde and the Gareloch, and on the Ayrshire coast the ports of Troon, Irvine, Saltcoats, Ardrossan and Largs. In 1906 there were 195 boats and 256 fishermen and boys belonging to the district. The statistical records in the Officer's books go back to the year 1855, but it is to be noted that at that time,



and up to and including the year 1862, the limits of the district were much greater, comprising the coast right round to the upper parts of the Solway. In 1863 the coast from (and including) Ayr southwards was formed into the district of Ballantrae, referred to below. The tables referring to the district will be found appended (pp. 115, 127).

The gross quantity of herrings landed in the district in the years 1855-1906 amounted to 141,098 crans, or about 493,850 cwts., giving an annual average quantity of 2713 crans. The annual fluctuations ranged from 182 crans to 33,640 crans. In the first half of the fifty-two years, 1855-1880, the quantity of herrings landed in the district was 97,819 crans, giving an annual average of 3760 crans; in the second half, 1881-1906, the aggregate quantity was less than half of this, viz., 43,279 crans, the annual average being 1660 crans. Taking the period from 1863, since the district had the limits it has at present, the aggregate quantity landed was 141,098 crans, the annual average for the forty-four years being 2807 crans. In the first half of this period, 1863-1884, the quantity landed was 88,722½ crans, the annual average being 4033 crans; in the second half, 1885-1906, the aggregate was 34,795½ crans, the annual average being 1581 crans. The great difference was caused by quite an exceptional and abnormal fishing in 1868 and 1869, as explained below, when over 50,000 crans were landed. If these be deducted, then the average for the forty-two years falls to 1743 crans, and the average of the remaining twenty years of the first half of the period to 1920 crans, as compared with the 1581 crans for the last twenty-two years. The catch in this district has thus fallen on the whole.

Taking the whole period in groups of ten years, the annual averages are as follows:—

1857-1866.	1867-1876.	1877-1886.	1887-1896.	1897-1906.
2,318	6,472	1,634	1,587	1,689

And in five-yearly periods the averages are:—

1857-61	..	1,642	1882-86	..	1,864
1862-66	..	2,994	1887-91	..	2,077
1867-71	..	11,637	1892-96	..	1,097
1872-76	..	1,307	1897-1901	..	400
1877-81	..	1,404	1902-06	..	2,978

The table of the annual quantities landed and the curve representing them show that the years 1855, 1860, 1862, 1865, 1868, 1869, 1870, 1882, 1888, 1905, and 1906 were above the general average for the whole period, while the lowest years are to be found from 1896 to 1901.

Unfortunately, the records of this district, so far as the locality where the fish were caught is concerned, are very defective, particularly in the early years. From occasional notes, it may be surmised that there was usually a fishing in June and July in the earlier part of the period in Luce Bay and neighbourhood, but probably the chief fishing was on the coast of Ayrshire and over to the coast of Arran. In 1862 the summer fishing was on the Ayrshire coast, the total for the year being 5260 crans, the catches in the principal months being as follows:—

July.	August.	September.	October.
896	2,564	1,675	55

In 1863 no information is given. In 1864 the fishing appears to have been over at Arran mostly, and in November some were taken in Irvine Bay and Saltcoats Bay. In 1865 the summer fishing appears also to have been chiefly in the neighbourhood of Arran, but in November the herrings set in in great abundance to Irvine Bay, the oldest fisherman, it is said, not remembering such heavy catches with drift-nets as were then obtained, and the herrings were taken close to the shore and even in Irvine Harbour. The weekly catches may be given, the number of crans of herrings landed at the various ports being as follows:—

Week ended	Troon.	Irvine.	Saltcoats.	Ardrossan.	Total.
4 Nov. -	10	777	133	..	920
11 " -	8	545	320	17	890
18 " -	330	22	..	..	352
25 " -	1	..	..	..	1
2 Dec. -	125		34	..	159
9 " -	342		18	..	360
16 " -	109		21	..	130
23 " -	65		..	..	65
30 " -	300	..	..	..	300
6 Jan. 1866	400	5	..	..	405
13 " "	.	12	20	..	32

After the 13th January the fishing fell off, only a few hundreds of herrings being caught up to the end of the month. The totals for the various months for the district are as follows:—

June.	July.	August.	September.	October.	November.	December.	January.
24	249	1,200	232	113	2,322	855	437

In 1866 the summer fishing appears to have been mostly near Arran, and in November the herrings were again tolerably abundant in Irvine Bay, appearing about the same time, viz., 3rd November. Later in the month they were found in Ayr Bay. The fishing was continued to January 25th, but with less success, the weather being stormy. The monthly totals are these:—

June.	July.	August.	September.	October.	November.	December.	January.
38	580	506	37	132	927	67	309

The total for the year was 2724 crans.

There is no information for 1867, except that on 14th December it is said that "the winter fishing on the Ayrshire coast has done little or nothing as yet," and no shoal appeared on the coast as in the two previous years. The total for the year was 1266 crans, of which 309 crans were taken in January, as above stated.

The year 1868 is a memorable year in the fishing annals of the Greenock district. In the summer the fishing was rather poor, and it was noted that there did not appear to be a shoal of any extent on the coast. The total quantity up to the beginning of October was 1425

crans. In the week ended 3rd October 80 crans were landed, the place of fishing being unspecified. On the following week 194 crans were taken, and the Officer (now a new one, Mr. John Bain) reported that upwards of 100 crans were landed at Greenock, from which place 20 boats were fishing, and he added—"On Friday and Saturday last (9th and 10th October) the fishing in the Clyde was remarkably good. It is prosecuted opposite Greenock, and on Friday afternoon good takes were got farther up the Clyde, opposite Port-Glasgow." It is possible that the fishing in this locality had started a little before, and that part of the 80 crans recorded for the preceding week were caught there; but it can scarcely have begun before 26th September, when the previous Officer notes that the Ayrshire boats had been doing nothing as yet, and had gone to Loch Fyne.

As the season advanced the fishing in the estuary of the Clyde increased, and boats from other districts and from the East Coast were attracted to Greenock. The herrings were caught by seines between Greenock and Helensburgh, opposite Port-Glasgow, and sometimes as far up as between Greenock and Dumbarton, a very unusual occurrence. The number of boats increased to a maximum of 340 in November and December, and they fished day and night; the weekly catches increased to 6000 crans (or about 6,000,000 herrings) in November, and the Officer noted that, notwithstanding the great fleet of boats all using the seine-net—often improvised from drift-nets—busily engaged day and night amongst them, and steamers continually plying up and down, the shoal still remained in the narrow estuary, and seemed rather to increase than diminish. On 12th December he adds—"Notwithstanding that a considerable number of boats (up to 340) have been during the past *nine* weeks constantly engaged trawling for herrings in the Clyde in comparatively shallow water, the herrings appear to be as abundant as when the fishing commenced, evidently showing that trawling does not frighten away the herrings, as is sometimes alleged by those opposed to this mode of fishing."

Shortly after this, however, the fishing fell away. On 18th and 19th December very few herrings were taken, and the total catch for the succeeding week fell to 120 crans. It was believed that the fish had gone to Loch Long and Loch Goil, where, as stated above, a great fishing occurred. Towards the end of January a fishing revived opposite Greenock and was continued to the 27th, the last herrings being taken opposite Gourrock, and it was supposed that the shoal was making its way down to the sea. The weekly totals for the district, and which refer to the fishing in the estuary, are as follows:—

Oct. 10 ..	194	Nov. 7 ..	2,496	Dec. 5 ..	2,600
" 17 ..	383	" 14 ..	5,800	" 12 ..	3,500
" 24 ..	1022	" 21 ..	6,000	" 19 ..	3,000
" 31 ..	1500	" 28 ..	5,500	" 26 ..	120
				31 ..	20

The monthly totals for the district are these:—

July.	August.	September.	October.	November.	December.	January.
576	401	428	3,179	19,796	9,240	470

In the following year, 1869, in the belief that there were still herrings in the Clyde opposite Greenock, a few trials were made at the beginning of June, but none were caught. In this month and July the herrings

landed were caught apparently off the Ayrshire coast, and it is noted on 10th July that the "appearance" of herrings on the coast was good. On the 4th September it is noted that 20 crans were taken on the grounds opposite Greenock, and the fishing continued here during the month, without, however, very great success. At the beginning of October it is stated that the principal fishing grounds were the banks between Greenock and Helensburgh, but that although numerous boats (161) were employed both night and day, the results were not yet encouraging. On the 18th October 70 crans were caught, and in the week ended 23rd 400 boats were prosecuting the fishing, and 3000 crans were taken. The herrings, the Officer noted, were scattered along the Tail of the Bank, and were got from the entrance to the Gareloch up to opposite Port-Glasgow. In the next week 6000 crans were taken by 478 boats, after which the weather became somewhat stormy and interfered with the fishing. Early in November the herrings began to get scarce, the weekly catch falling to 120 and then to 14 crans, and the fishermen were of opinion that the herrings had been driven from the Tail of the Bank by the great quantity of fresh water coming down the Clyde, and that when the water became clearer the herrings might return. At the end of November the fishing did, indeed, improve slightly, 844 crans being taken in the week ended 27th, but they were caught farther down the Clyde, opposite Gourrock and Kilcreggan, though a few were still got opposite Greenock. In December a small quantity were taken, chiefly in the channel and down by Wemyss Bay and Gourrock. In the week ended 8th January the fishing was at Largs and Fairlie, and between those places and the Cumbræes, and it appeared that the herrings were going farther and farther to sea; none were secured after that week. The total catch for the year was 16,670 crans, of which 470 were taken in January. The particulars for the months and the chief weeks are as follows:—

June.	July.	August.	September.	October.	November.	December.	January.
...	...	...	142	12	3,200	302	...
...	...	...	40	43	120	...	300
...	...	...	36	2,996	14	...	...
...	...	...	53	6,000	884	200	...
...	...	...	205	...	...	150	...
101	706	1,036	476	9,051	4,178	652	300

In 1870 the fishing on the Ayrshire coast, of the usual kind, continued till the end of August, when it began to fall off. In the first week of September two boats tried the grounds opposite Greenock, and got a few hundreds of very small herrings. In the next week about 40 boats got 70 crans, also very small fish, running about 1400-1600 to a cran, and so on throughout the month. In October the fishing in the district was almost entirely confined to Greenock; towards the end of the month it fell off, and very few were got at the Tail of the Bank afterwards, either in November or December: those taken in the latter month were caught farther down by Inverkip and Wemyss Bay and over towards the Cloch Lighthouse. The last entry is for the week ended 24th December, but 40 crans were landed in January, place not specified. In this year the total was only 4350 crans, of which 300 crans were obtained in January. The particulars for the months, and for the weeks during which the fishing was in the estuary of the Clyde, are as follows:—

June.	July.	August.	September.	October.	November.	December.	January.
...	...	...	66	40	64	598	...
...	...	...	4	20	68	150	...
...	...	...	113	20	...	200	...
...	...	...	60	22	108	100	...
...	...	...	75	...	...	...	...
552	1,146	644	318	102	240	1,048	40

In September, about 205 of the total crans landed were caught off Greenock; in October the quantity was 87 crans, the rest being got on the Ayrshire coast; in November 68 crans were got near Greenock, and 172 crans on the Ayrshire coast; in December, in the first week none were got at the Tail of the Bank, most coming from the entrance to Loch Long and the Holy Loch; in the second week about 104 crans were taken between Wemyss Bay and Inverkip, the rest on the coast of Ayrshire, and a considerable quantity of those taken in the next week were also caught near Inverkip.

In 1871 the grounds off Greenock were tried, and over towards Helensburgh in October, but only a few crans of herrings were obtained, the weekly catches being 6 crans, 10 crans, 4 crans. In the early part of November some herrings were taken on the Tail of the Bank, and this drew a number of boats to the place. The particulars of the weekly fishing on these grounds are as follows:—

			Boats.	Crans.				Boats.	Crans.
Oct.	7	-	12	6	Nov.	11	-	50	58
"	14	-	10	10	"	18	-	50	220
"	21	-	4	4	"	25	-	30	100
"	28	-	..	..	Dec.	2	-	80	300
Nov.	4	-	8	8	"	9	-	70	700

During the last week, while fishing was also carried on on the Tail of the Bank, a considerable proportion of the fish were taken between Gourrock and Largs. No herrings appear to have been taken after this, and none were obtained in January.

In 1872 the total landed for the year was only 553 crans. Several trials were made at the Tail of the Bank in the latter part of the year, but with no success. The fishing in the following years was not very successful until 1882, and the particulars given as to the locality of fishing are scanty, but it appears generally to have been on the Ayrshire coast and towards Arran.

In 1882 the total was 3734 crans; such information as is given indicates that the fish were taken chiefly at Arran and about the Cumbraes: there is no mention of the Clyde estuary. In 1888 the aggregate was 3071 crans. In June and the early part of the season the fishing was chiefly in Gareloch, where the fishing is said to have been better than for many years. Later it was at Arran, especially about

Sannox, though there was again a slight fishing in Gareloch about the middle of September.

In 1905, when the aggregate was 4455 crans, the bulk was obtained in September and October, and the chief fishing places were in those months the waters between the Ayrshire coast and Arran.

In 1906 the total amounted to 7865 crans; there is an entry of 687 crans for winter fishing without specification of grounds. The herrings in August and September were chiefly caught on the east coast of Arran, in the channel between Ardrossan and Arran, and in Brodick Bay. In November there was a fishing on the coast of Ayrshire, but the quantity taken was small; later in the month it was farther up the coast, off Largs, and in the end of the month in Gareloch, where a considerable shoal of herrings appeared. In December the fishing continued with success in Gareloch, and apparently also in January, 1907, for the first entry for that year, on February 9th, represents 4844 crans as having been taken in the winter fishing to date. In February, 1907, the fishing took place off Greenock and in Largs Bay, and large quantities of herrings were taken. In March this fishing fell off, the last, 25 crans, being taken in the week ending March 9th. This then represents another incursion of shoals to the upper reaches of the Clyde. The quantities (crans) landed in each of the months are as follows:—

1906.						
January(?)	July.	August.	September.	October.	November.	December.
687	141	1,304	1,630	451	2,014	1,638

1907.		
January.	February.	March.
4,844	2,709	25

The catches by the week during the winter fishing in the upper waters are as follows, the first few entries representing the fishing on the northern part of the Ayrshire coast:—

Nov. 3,	38	Dec. 8,	377	Jan.	Feb. 9,	642	Mar. 9,	25
" 10,	65	" 15,	575	?	" 16,	624		
" 17,	417	" 22,	168		" 23,	1,276		
" 24,	641	" 29,	518		Mar. 2,	167		
Dec. 1,	853							
<hr/>		<hr/>		<hr/>		<hr/>		<hr/>
2,014		1,638		4,844		2,709		25

It may be noted that a period of about thirty-seven years has elapsed since great shoals appeared in these waters.

#### *Ballantrae District.*

The limits of this district, as already stated, extend from and include the town of Ayr on the Ayrshire coast, round to the Solway, embracing the whole of the Scottish coast of the latter. In 1906 the number of boats belonging to the district was 346, while there were 587 resident fishermen and boys. As mentioned above, until 1863 this district was included in the district of Greenock, so that the statistics available are for the forty-four years 1863–1906. In this period the gross quantity

of herrings landed in the district amounted to 398,689 crans (about 1,395,400 cwts.), giving an annual average for the period of 9061 crans. In the first twenty-two years, 1863–1884, the gross quantity of herrings landed was 228,592 crans, the annual average being 10,390 crans; while in the last twenty-two years, 1885–1906, the quantity was 170,097 crans, with an annual average of 7732 crans—showing, therefore, a considerable reduction in the second period. The annual average for each of the ten-yearly periods are as follows:—

(1857–1866	..	2,129)	1887–1896	..	8,566
1867–1876	..	4,535½	1897–1906	..	5,397½
1877–1886	..	20,518½			

The first of these periods, of course, includes only four years. The annual mean quantity in five-yearly periods was:—

1862–66	..	2,129	1887–91	..	14,201
1867–71	..	2,606	1892–96	..	2,931
1872–76	..	6,465	1897–1901	..	4,412
1877–81	..	24,088	1902–06	..	6,383
1882–86	..	16,949			

The variations from one year to another have been very marked in this district, the smallest quantity in any one of the years being in 1863, when the total landed amounted to 825 crans; the largest was in 1880, when the aggregate amounted to 37,600 crans. The great fluctuations in this district have been owing chiefly to the variation in the yield of the winter and spring fishing. The summer fishing, as a rule, is not of great account, and it is not at present worth while attempting to follow the movement of the fishing in detail. Suffice it to say that it begins usually in May, and in that and the following month is carried on generally on the Ayrshire coast, sometimes into August; the fishing then, as a rule, passes to the coast of Arran and about the south end of that island, and into Kilbrennan Sound later and the Argyllshire coast.

The great fishing is the winter and spring fishing on the coast of Ayrshire, which occasionally begins in November, more commonly in December, and it may not be till January, or even later. Shoals of herrings commence to congregate on the coast, sometimes in the southern part, off Loch Ryan and Corsewall Point, and sometimes in the northern part of the district, about Ayr Bay or neighbourhood. The fishing is then carried on mostly by trawl nets, or seines, and sometimes large catches are secured. In February, usually in the third week, the shoals settle down on the spawning grounds near the coast, particularly opposite Ballantrae, and great quantities of herrings may be taken in February and March. The fishing closes in March as a general rule, though occasionally a small quantity is got at the beginning of April near the shore.

The chief bank on which the herrings spawn is of an irregular elongated form, and lies off the coast between Bennan Head on the north and a point about three miles south of the village of Ballantrae. It begins about one mile from the shore and extends to over three miles from it, the depth ranging from about six to thirteen fathoms, and the bottom is formed chiefly of stones, gravel, and coarse sand. The spawning is not, however, always and not perhaps usually confined to this area. An elevation of the bottom, with depths from six or seven to fifteen or sixteen fathoms, extends along the coast from near Girvan to

Loch Ryan, and herrings appear to spawn in the neighbourhood of the banks, although the Ballantrae Bank is by far the most important locality, and it is here that the herrings are chiefly obtained from the middle of February to the end of March.

As this fishing is an important one, I have prepared a table, so far as the information is available, showing the quantities taken in the different months in the various years. The statistics for the "winter" fishing in the Greenock district from 1855 to 1862 (after which Ballantrae was separated) show the following, but it is unknown where the herrings were taken :—

1855	1,391 Crans (to 23rd June).	1859	52 Crans (to 18th June).
1856	70 " " 14th "	1860	17 " " 9th "
1857	15 " " 13th "	1861	50 " " 22nd "
1858	7 " " 5th "	1862	4 " " 7th "

These figures show, at all events, that the winter fishing in these years at Ballantrae Banks or neighbourhood was small, and it is to be noted that a close-time which was established in 1860,\* from 1st January to 31st May, for the stretch from Ardnamurchan to the Mull of Galloway, put a stop to the spring fishing on this coast. By another Act of 1865,† the close-time was altered to the period from 1st February to 31st May, and it was made subject to the Sea Fisheries Act of 1868, and has never been enforced. It is stated in the report of the Commissioners of 1877 that seining for herrings commenced on the Ballantrae Banks in 1878; but seines are mentioned in the records as having been employed in the winter fishing in January, 1871, though not apparently on the Banks, where, indeed, the abundance of set-nets or so-called trammels prevented their use for several years. It is to be noted further that by a byelaw (No. 18) that came into force in 1902, seine-trawling for herrings was prohibited from the 15th January to 31st March in each year within an area embracing Ballantrae Banks and the waters south to Corsewall Point.‡

The table showing the takes of herrings landed in the four months of each season, December–March, is appended.

\* By the Act 23 and 24 Vict., c. 92.

† 28 and 29 Vict., c. 22.

‡ The area is thus defined :—"A straight line drawn from Bennan Head, Ayrshire, to a point three miles north-west (magnetic); a straight line drawn from Corsewall Point Lighthouse to a point three miles north-north-west (magnetic); and a straight line joining the above-mentioned points."—*Twentieth Annual Report*, Part I., p. 258.



Years.	Decem-ber.	Janu-ary.	Febru-ary.	March.	Total.	Notes.
1863-64	...	...	...	...	...	
64-65	6	...	...	...	6	
65-66	1,695	1	...	...	1,696	
66-67	7	66	4	...	77	
67-68	...	70	?	?	386	11th January to 1st July.
68-69	13	...	...	...	13	
69-70	...	(14)	?	?	1,649	1st February to 1st June.
1870-71	(101)	(35)	?	?	1,621	" " " 13th May.
71-72	10	?	?	?	1,725	Winter and Spring to 1st June.
72-73	...	?	?	?	2,025	" " " "
73-74	...	?	?	?	4,890	" " " 30th May.
74-75	...	?	?	?	9,197	" " " 22nd "
75-76	...	?	?	?	6,071	" " " 13th "
76-77	...	?	?	?	10,254	" " " 12th "
77-78	...	5,075	10,958	1,779	17,820	Including 23 crans in April.
78-79	...	7,930	6,276	4,974	19,594	" 414 " "
79-80	4,085	5,200	6,518	19,452	35,277	
1880-81	970	2,872	9,310	11,922	25,074	
81-82	178	1,183	6,188	1,337	8,886	
82-83	116	3,697	1,766	17,566	23,145	
83-84	143	2,813	8,465	3,280	14,707	Including 6 crans in April.
84-85	416	744	5,755	14,094	21,009	
85-86	227	184	2,224	2,352	4,987	
86-87	37	48	754	9,074	9,913	
87-88	70	450	2,127	6,938	9,585	
88-89	913	875	8,981	759	11,528	
89-90	1,070	296	6,920	978	9,264	
1890-91	8,736	1,854	5,047	...	15,637	
91-92	2,946	...	1,577	1,736	6,259	
92-93	65	...	454	...	519	
93-94	...	...	3	72	75	
94-95	...	...	117	1,164	1,281	
95-96	...	...	194	150	344	
96-97	...	...	46	423	469	
97-98	...	?	?	?	30	" Winter fishing."
98-99	...	?	?	?	1,247	" " "
99-1900	190	...	449	3,664	4,113	
1900-01	8	...	5,652	3,743	9,395	
01-02	...	2,450	3,072	1,316	6,838	
02-03	...	530	177	25	732	
03-04	...	92	461	322	875	
04-05	?	...	...	...	?	{ 108 crans, 1st Oct. to 31st Dec.
05-06	?	584	183	389	?	{ 106 crans, 1st Jan. to 27th May.
06-07	10,195	337	542	555	11,629	*and 2,881 crs. 1st Oct.-31st Dec.

With the other table it enables us to see that there was no great winter fishing from 1855 to 1874, and that until 1870 the winter fishing was chiefly in December. From evidence given in 1864 before the Royal Commission it appears that the spring fishing for spawning herrings on the banks came to an end in 1856, and that it was declining for some years before that time; and that the herrings did not return until 1862, when the close-time was in force.\* In the late autumn of 1865, as appears from the notes of the Fishery Officers, herrings came back in abundance to the Ayrshire coast. None were taken in October of that year, but on 3rd November the fishermen at Ayr

\* *Ibid.*, p. 1189.

struck a dense shoal, and during that month and December heavy catches by drift-nets were landed from Ayr Bay and neighbourhood, chiefly from shallow water, three and four fathoms. The total taken in these two months was 3410 crans. In the following January only a single cran appears to have been caught, but in November, 1866, the herrings returned to the coast, where good catches were obtained, principally in Irvine Bay, but it did not last long. In January, 1867, herrings were got inshore at Dunure, south of Ayr Bay, and in the early part of November they set in, as they had done in the two preceding years, on the northern part of the coast, in Irvine Bay, but they did not stay long and comparatively few were taken. In 1868 they did not appear there, but in November some were caught in Loch Ryan, at the southern extremity of the coast.

In January, 1869, several boats tried along the coast between Dunure and Girvan, but got nothing, and the Officer noted that from the number of gannets upon the spawning banks at Ballantrae on 22nd and 23rd January, and the quantity of herrings found in the stomachs of cod and other fish landed (the two usual signs), the fishermen were in hopes of a good fishing; but there is no further entry, and apparently no fishing took place. The summer fishing this year was very successful on the Ayrshire coast, the best for twelve years; in September and October a few were caught in Loch Ryan. In the spring fishing of 1870 and up to 1st June, 1649 crans of herrings were taken, but there are no particulars furnished as to the localities or the months. The summer fishing was again successful on the Ayrshire coast, falling off towards the end of July, and in August and till November takes were got in Loch Ryan. In the next year the winter and spring fishing yielded 1621 crans up to 13th May, but no particulars are furnished; the summer fishing was unsuccessful. Seines are mentioned as having been used in January. It is also mentioned at the beginning of September that immense shoals of herrings had been seen at the mouth of the Clyde and near Ailsa Craig by passing vessels. In 1872 the catch up to 1st June was 1725 crans, and the summer fishing was very poor. Herrings were again taken in Loch Ryan in November. In 1873 the catch up to 1st June was 2,025 crans; the summer fishing was apparently on the Ayrshire coast and successful till August; and in September and October there was a slight fishing off Ayr, and off Irvine in November. In 1874 the winter and spring catch, up to 30th May, was 4890 crans; the summer fishing was on the Ayrshire coast and then at the south end of Arran, and the last herrings were taken at the beginning of September. In 1875 the winter and spring catch increased to 9197 crans, but no particulars are given; the summer fishing on the coast was extremely unproductive, such as were landed coming mostly from the other side of the Firth. In 1876 the quantity taken up to 13th May was 6071 crans, and the summer fishing was poor. Next year the winter and spring fishing yielded 10,254 crans (up to 12th May); the summer fishing was not successful, and the last herrings were landed in August.

In 1878 particulars are for the first time given of the winter and spring fishing, which, as we have seen, had been increasing in the previous four or five years. The total catch amounted to 17,820 crans. On 5th January it is reported that herrings were abundant all along the Ayrshire coast, drift-nets, set-nets, and seines being used. On 19th January a large shoal was said to be off Ballantrae; in the week ended 2nd February, 3820 crans were landed, the best fishing being off Woodlands, near Girvan; in the next week the quantity landed was 4462 crans, mostly taken off Turnberry Point and Girvan by seines. On 16th

February it was stated that as there was a favourable appearance of herrings on the spawning banks the fishing for the rest of the season would be almost entirely by set or trammel-nets ; and on 23rd February it was noted that the herrings had now settled on the banks for spawning. In the week ended 2nd March, 4600 crans were landed, all taken by trammels. The weather then got very stormy, and only 22 crans were landed in the following week, which had been picked off the trammel nets, the rest of the fish being unfit for food, the nets not being hauled for some days. In the middle of March the gannets began to get scarce, a bad sign, and the fishing declined and ended in the last week of March, though 23 crans were taken at the beginning of April at Lendalfoot, near Bennan Head. The quantities landed, and the number of boats fishing in the various weeks, were as follows :—

January.		February.		March.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
31	95	165	4,462	182	22
48	230	154	206	182	1,261
83	751	191	1,690	178	474
73	174	182	4,600	35	22
151	3,820				
	5,070		10,958		1,779

It is to be noted that as a general rule the fishing consists of two parts ; the first is carried on in the neighbourhood of the spawning banks, on the shoals as they are collecting, and the second from a little after the middle of February, among the spawning herrings on the banks. The summer fishing this year was of little importance, the last herrings being taken in the beginning of August ; in November and December a few were got on the Arran and Argyllshire coasts.

In 1879, when the total for the winter and spring fishing amounted to 19,594 crans, the fishing began to the south of the spawning grounds, that is, in the opposite direction to the locality where it opened in the previous year. The herrings in January were caught off Loch Ryan and Corsewall Point by seines and drift-nets. By the beginning of February they were taken along the coast from Corsewall to Ayr, a stretch of 35 miles, and mostly between three and five miles from shore. In the first week of February the heaviest takes were got near the spawning banks off Ballantrae ; drift-nets, seines, and trammels were used this month, and some catches were made off Loch Ryan. In March trammels alone were used on the banks ; in the week ended 15th many of the fish were spent, and the best catches were obtained off Bennan Head, to the north of the banks. In this locality and at Lendalfoot, still further north, 414 crans of herrings, mostly spent, were got by trammels early in April, the fishing closing on the 9th of that month. It was thus late in closing, and it may be noted that no herrings were secured in the previous December, the shoals being late in arriving. The weekly quantities and the number of boats engaged were as follows :—

January.		February.		March.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
56	90	304	104	204	1,220
188	1,334	125	410	210	921
290	3,078	251	1,755	199	1,783
304	3,428	251	4,007	98	1,050
	7,930		6,276		4,974

The summer fishing on the coast was poor, most of the boats fishing at Arran and on the Argyllshire coast. About 18th or 19th October a large shoal of herrings entered Loch Ryan, but went out in a day or two before many were caught; very few herrings were taken in November, but an unexpectedly early commencement of the winter fishing was made off Loch Ryan on 11th December, and during that month 4085 crans were secured there about two to five miles from the coast. In January, 1880, the fishing continued in that quarter, extending towards the end of the month from Corsewall to Ballantrae. In the week ended 21st February the herrings were settling on the spawning banks; at the beginning of March the best takes were got on the banks by seines, after which the trammels were too crowded for them, and the seiners left. The fishing went on to the end of March, and the enormous quantity of 35,277 crans (about 123,570 cwts, or more than 35,000,000 herrings) were secured, which, at the prices then ruling, were worth considerably over £70,000. The weekly returns are these:—

December.		January.		February.		March.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
..	..	..	..	307	2,928	127	829
46	288	290	499	210	512	253	4,806
186	2,722	310	2,053	185	558	267	4,231
202	1,075	364	2,624	302	2,520	?	9,586
..	..	19	24	..	..	..	..
	4,085		5,200		6,518		19,452

The summer fishing, up to the end of July, was successful on the Ayrshire coast this year, especially off Girvan, but the herrings disappeared in August; in October some were taken in the middle of the Clyde, and at the end of the month at Loch Ryan; in November, and still more in December the takes in that neighbourhood increased, and it is

noted in December, that the chief grounds extended to twenty miles off Corsewall Point. In January, 1881, the best areas continued to be off Corsewall Point and Loch Ryan, as in the previous year, and even to the south of Corsewall. In February the precise positions where the herrings were taken are not specified, but "the usual grounds" are referred to, and by far the largest quantity this month were taken by seines; in one week the record of 5540 crans was reached. On 12th March it is said the herrings were "on the eve of spawning" and were inferior; on 19th March they were largely spent fish, and the fishing closed at the end of the month. The weekly particulars are as follows:—

December.		January.		February.		March.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
171	910	290	2,125	335	793	256	452
?	40	158	62	255	237	158	1,562
130	20	407	120	297	2,740	180	1,489
..	..	345	565	315	5,540	?	8,419
	970		2,872		9,310		11,922

The aggregate thus amounted to 25,074 crans. The summer fishing on the coast was very poor, most of the boats going to Arran and Kilbrennan Sound. At the beginning of November herrings were taken in Loch Ryan, but heavy storms came on and put an end to the fishing; some were also got there in December, and at the end of the month off Ballantrae. In January, 1882, and again in February the fishing was much interrupted by the storms, but this does not account for the comparatively small catches; for example, 108 boats fishing in Loch Ryan for a night at the beginning of January got only a few hundreds of herrings amongst them, and three weeks later 236 boats fishing for four nights took altogether only 383 crans. The bulk of the herrings up to the week ended 11th February were landed at Stranraer, and presumably taken in or near Loch Ryan or Corsewall Point. On 11th March a gale from the west came on and, it is said, dispersed the herrings, and the fishing came to a stop. It is clear, however, that the shoals this year were very much smaller. The quantity taken each month was as follows, the total being 8,886 crans:—

December.	January.	February.	March.
178	1,183	6,188	1,337

The summer fishing was carried on during May and June mostly on the Ayrshire coast, especially near Girvan, and towards the end of June and afterwards, on the other side of the Firth, in Loch Fyne and Kilbrennan Sound. The winter fishing commenced on 8th December, near Girvan, and continued there and also at Stranraer, but the aggregate for the month was small. In January, 1883, the herrings were got both in the south and the north, particularly at Lendal Bay, a few miles north of the spawning banks, in 9-15 fathoms. In February there were several gales which

interrupted the fishing, but in the week ended 3rd March the extraordinary quantity of 16,060 crans was landed; the catch of one pair of trawlers filled eight "skiffs" or fishing boats, and another boat sank with the weight of herrings. The fishing on the banks was by seines as well as trammels, but trammels alone were used towards the end of the fishing. The catches gradually declined, and none were taken after 24th March. The aggregate for the season was 23,145 crans, the details being as follows:—

December.		January.		February.		March.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
..	..	98	585	262	87	320	16,060
2	2	182	796	132	327	130	774
21	15	330	2,196	10	19	48	339
70	32	246	120	408	1,333	57	393
93	67	..	..	..	..	..	..
	116		3,697		1,766		17,566

The summer fishing on the coast was not important. The winter fishing commenced on 6th December, the place of fishing being off the harbour of Girvan, but little was got during the month. In January herrings were found at Saltcoats and also apparently about Loch Ryan; at the middle of the month they were chiefly landed at Stranraer, but good takes were also got between Ayr and Maidens. The greatest quantity was taken in February, and it is mentioned that in March one seine boat secured 408 crans in four hauls of the net one week, which sold for £599. The fishing closed later than usual, on 2nd April, and the fishing-ground at the end of March was Ardmillan Bank, three miles south of Girvan. The total catch amounted to 14,707 crans, apportioned as follows:—

December.	January.	February.	March.	April.
143	2,813	8,465	3,280	6

Perhaps to the total should be added 238 crans taken on Ballantrae Bank by trammel nets in the week ended 15th April. The summer fishing was more successful than usual on the Ayrshire coast, and herrings were got north of Girvan in August, but after that most of the fish landed came from other quarters, as Kilbrennan Sound. In December some herrings were caught off the mouth of Loch Ryan as well as within it, and others at the Cumbraes, the latter greatly predominating in the last week of the year. And in January, 1885, most of the herrings at first taken were got in the same quarter; later they were secured between Girvan and Turnberry Point, to the northwards, but the quantity in January was inconsiderable. In the middle of February most of the catch was taken on the north bank off Ballantrae by seines, and in March on the bank by the same method of fishing, the catch in the week ended 14th March amounting to 12,033 crans. After this the fishing

declined, and on the 24th the trammels were clean and the fishing stopped. The quantities in the various weeks, the total amounting to 21,009 crans, were these :—

December.		January.		February.		March.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
..	..	6	99	189	382	271	1,666
16	87	..	..	395	712	289	12,033
..	..	94	34	325	4,102	160	360
66	128	128	530	120	559	35	35
..	..	84	81	..	..	..	..
	416		744		5,755		14,094

The fishing in summer on the Ayrshire coast lasted only till early in July, most of the boats going to Kilbrennan Sound. No herrings were landed between 12th September and the week ending 26th December, when 227 crans were taken by 38 boats at Girvan and Maidens. In January, 1886, the weather was very stormy, and the first herrings were landed on the 9th, but only a few crans; the next were taken in the week ended 23rd by drift-nets on Ballantrae Bank, and more were taken there in the following week. In February the fishing was slack, owing partly, it is said, to the low prices current; but that the herrings were scarce this season was shown in the week ended 27th February, when the weather was fine, and 285 boats were nightly at sea, while the catch totalled only 1121 crans. The fishing closed on 24th March, and was the poorest, it is remarked, since it commenced "about twelve years ago." The aggregate amounted to 4987 crans, apportioned as follows :—

December.	January.	February.	March.
227	184	2,224	2,352

The summer fishing on the coast was unimportant. In December some herrings were taken at Loch Ryan, but the fishing fell off, and trials on the Ayrshire coast towards the end of the month were without result. In January, 1887, small takes were got off Girvan and in the neighbourhood, but there was no "appearance" of herrings on the coast. About the middle of February the herrings were caught between Bennan Head and Ballantrae Bank, and in the week ended 26th on the bank itself. Little was caught until the week ended 5th March, during which the weather was calm and summer-like, when 5084 crans were landed, and in the next week 3707 crans. The officer notes that there was a great admixture of small and unmarketable herrings amongst those taken, especially by the seine-net, and quantities were used as manure. The season closed on 15th March, the aggregate being 9913 crans, apportioned as follows :—

December.	January.	February.	March.
37	48	754	9,074

In November and December most of the herrings landed were taken in Loch Ryan by trammel-nets.

In January, 1888, a large body of herrings came close inshore between Girvan and Turnberry, but they did not stay long. In February most were taken by seine on Ballantrae Banks, and they were very largely small and immature. But in the week ended 3rd March, 6786 crans of large and excellent herrings were caught on the banks, of which 6024 crans were got by seines and 762 by set-nets. After this little was done, a gale closing the fishing on 8th March. The aggregate was 9585 crans, as follows:—

December.	January.	February.	March.
70	450	2,127	6,938

There was comparatively little fishing on the coast in summer, but many herrings were taken in Luce Bay. The winter fishing began on 10th December between Duuure Head and Ayr Bay, where it continued throughout the month, principally with drift-nets.

In January, 1889, the fishing-place was chiefly between Girvan and Turnberry Point, up to near the middle of the month, and then from three to six miles south of Girvan and close to the shore. The first part of February was stormy, and little was caught; towards the end of the month the herrings were taken on Ballantrae Banks both with seines and trammels, and they were of a good size. In March the fishing fell off, and gradually came to a close on 15th March. The quantity for the season was 11,528 crans, apportioned as follows:—

December.	January.	February.	March.
913	875	8,981	759

At the end of November the winter fishing commenced off Culzeau Castle, north of Turnberry Point; in December it continued in the same neighbourhood between Maidens and Dunure. In January, 1890, it was in the same region, north of Turnberry, till the close of the month, when the herrings were taken chiefly between Girvan and Turnberry Point. In the first week of February the principal ground was Ballantrae Banks, where it continued; on the 22nd, large numbers of haddocks were caught on the bank by the seine-nets, and were found to be gorged with herring spawn. The fishing closed very early, on 4th March, the shoals having come earlier and left sooner. The aggregate catch was 9264 crans, the weekly particulars being as follows:—

December.		January.		February.		March.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
46	442	16	17	88	419	174	978
62	586	41	258	93	1,931	..	..
58	18	5	..	107	559	..	..
30	24	12	3	163	4,011	..	..
..	..	55	18	..	..	..	..
1,070		296		6,920		978	



Perhaps the catches in November should be added, which would bring the total up to 9861 crans. On 18th November a trial was made by eight boats off the Ayrshire coast, but no herrings were caught. On 27th and following days good catches were secured off Ayr Heads, in the south part of Ayr Bay, and so close inshore that a good many of the drift-nets were torn on the rocks. The fishing here continued throughout December with great success; in the week ended 20th, 5288 crans were taken, almost entirely by seine-net, off Ayr Harbour, within a few hundred yards of the shore, and in from two to seven fathoms of water. Towards the end of December the fishing in that locality came to a sudden termination, but it was renewed in January 1891 off the Heads of Ayr; in the week ended 10th the fishing was between Ayr and Dunure Head, but the shoal began to move south, and in the next week the totals fell to 32 crans. After this the weather was stormy for a time. The fishing in February was on Ballantrae Banks; in the first week, though the weather was fine, only 96 crans were taken, and in the second week only 20 crans; in the week ended 21st February 4875 crans were landed, mostly by seines, and there was a large proportion of small fish among them, and then the fishing came to an abrupt end, no herrings being got in March. The weekly particulars are these:—

December.		January.		February.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
47	637	75	247	92	96
139	2,276	144	1,545	124	23
184	5,288	48	32	224	4,875
132	535	..	..	225	53
..	..	66	30	..	..
	8,736		1,854		5,047

The total was thus 15,637 crans, of which more than half were taken in December. If the catch in the last week of November be added, the total is raised to 16,111 crans.

At the end of the year the herrings returned to Ayr Bay, but they were also taken in Loch Ryan, as they had been to some extent in October. Most were got off Ayr, and the fishing in Loch Ryan closed in the first week of December. During December the fishing was off Ayr Heads and neighbourhood. In January, 1892, the first week was stormy, and it was found that the herrings had left the ground; none were taken that month, and there was no "appearance" of herrings. It was not till the second week in February that they were again found on Ballantrae Banks, and the fishing went on there till the end of the month, without great success, and there were large numbers of small unsaleable herrings in the catches. In the first week of March the weather was fine, and 65 boats landed 1572 crans, of which 1059 crans were caught by trammels, and the rest by seines. The fishing closed on 8th March, the total for the season being 6259 crans. If the November catch be added, the

aggregate will be increased to 7222 crans. The monthly quantities were these:—

December.	January.	February.	March.
2,946	—	1,577	1,736

In May and June herrings were got in fair quantities on the Ayrshire coast, especially between Girvan and the Heads of Ayr. At the end of December, from the 27th to the 29th, herrings were again got on the grounds off the Heads of Ayr, but not in large quantity, and the shoal then disappeared. In January, 1893, no herrings were landed, trials on the usual grounds being almost or quite blank, and there being no "appearance" of shoals; cod were also scarce. The first herrings of the season were landed on 16th February, and were taken on Ballantrae Banks; but the catches were small, and the fishing closed at the end of February, the trammels being "clean." The total for the season was only 519 crans, landed as follows:—

December.	January.	February.	March.
65	—	454	—

The summer fishing was small, and no herrings were landed after August, the shoals having failed to appear at the end of the year. In January, 1894, there was no "appearance" of herrings on the coast, and no herring fishing. The first herrings of the season were landed on 16th February, when three crans were caught at Bennan Head, and this was the total for the month, the trammels set on the banks being practically "clean," only a few hundreds of herrings being caught. There was no "appearance" on the banks during the season. In the week ended 9th March the trammels caught nine herrings; but on the 16th and 17th 72 crans were taken, and this represented the fishing for the season, none being got afterwards. The aggregate was thus only 75 crans.

December.	January.	February.	March.
—	—	3	72

There was a tolerably fair fishing up to August on the Ayrshire coast, especially about Girvan and the Heads of Ayr; but no herrings were taken in the closing months of the year.

There was no herring fishing in January, 1895, the first herrings being landed in the week ended 16th February, and they were caught on the coast of Arran, about Whiting Bay, it being believed that a shoal was moving south towards Ballantrae. In the week ended 23rd February 116 crans of mixed sizes were taken on the banks by seines; but the fishing then was a complete blank till the week ended 9th March, when 169 crans were landed. After this, a few hundreds of crans were taken by trammel-nets, but on the 22nd the nets were "clean," and the fishing ended. The total for the season amounted to 1281 crans, thus apportioned:—

December.	January.	February.	March.
—	—	117	1,164

In this year no herrings were landed after 17th August.

In 1896 no herrings were caught in January, the first landed being on 15th February, and they were caught at the south end of Arran. In the week ending 22nd February, 194 crans were caught off Lendal Bay,

half-way between Girvan and the Ballantrae Banks; they were taken mostly by seines, and were very small herrings, from eight to ten inches in length, bringing only a few shillings a cran. At the beginning of March the banks were again tried, but no herrings were taken. On 14th March 150 crans were got on the banks, spent and ripe, but so small that the greater part were unsaleable, and were thrown back into the sea. The fishing closed on 14th March, the total for the season being 344 crans, of which 194 were taken in February and 150 in March. No herrings were got in November or December.

In 1897 the first herrings were taken on the Ballantrae Banks in the week ended 20th February, those caught by seines being small and unmarketable. No herrings were taken in the closing months of the year.

In 1898 the winter and spring fishing was again a failure, only 30 crans being landed, but the officer gives no information as to the place of fishing, or when they were taken. No herrings were landed after September.

In 1899 the winter fishing was better, the total being 1247 crans, but no particulars are given. There was a summer fishing of small importance on the Ayrshire coast, and in November and part of December herrings were got in Loch Ryan and neighbourhood.

In 1900 the first herrings were landed in the week ended 17th February, and they were taken rather to the south of Ballantrae Banks. During the rest of the month and in March herrings were taken of very fair quality, both by trammels and seines; in the week ended 10th, 2912 crans were secured on the banks, of which 1746 were taken by the seiners and 1166 by trammel-nets. None were taken after this, and the total for the season amounted to 4113 crans, thus apportioned:—

December.	January.	February.	March.
190	—	449	3,664

In December a few herrings were again taken in Loch Ryan, but only a few crans.

In 1901 no herrings were landed till the week ended 9th February. The banks had been visited, but there was no "appearance" of herrings; on the 8th, 100 crans were secured near Turnberry. In the week ended 16th, 1641 crans were got by seines on the outer edge of the Ballantrae Banks, and the fishing continued on the banks till the week ended 23rd March. The total for the season amounted to 9395 crans, as follows:—

December.		January.		February.		March.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
..	..	..	..	32	100	49	159
..	..	..	..	70	1,641	66	3,205
..	..	..	..	116	2,107	31	379
?	..	..	..	118	1,804	..	..
	8		..		5,652		3,743

No herrings were taken in December.

In 1902 the fishing commenced on 10th January, when 14 crans were taken at Dunure and Maidens Bay, and during the rest of the month there was a good fishing between Dunure and Turnberry, the total for the month being 3072 crans, and the herrings were caught close in to the shore. In the first part of February the fishing was pursued in the same quarter, and south as far as Girvan, but drifters also caught considerable quantities between Ballantrae and Corsewall Point. In the week ended 22nd February, most of the herrings were got about Bennan Head and the northern end of the protected area, and this was also the case in the following week. The fishing came to an abrupt end on 8th March. The total for the season was 6838 crans, as follows:—

December.	January.	February.	March.
—	2,450	3,072	1,316

It is to be noted that this was the first season in which the bye-law closing the banks to seiners came into force, and this, no doubt, reduced the quantity landed; but it appears several of the seine boats made hauls within the area. No herrings were landed in the district after September.

In 1903 the herrings were caught in Ayr Bay and to Turnberry Point, close inshore, from January 10th to the end of the month and well into February, but a fair fishing was also secured by trammels in Loch Ryan from the end of January to the middle of February. On 21st February it was reported that there was a good "appearance" of herrings in the vicinity of the spawning banks, but the weather came on stormy, and very little was secured, the herrings leaving on 14th March. The total for the season was 732 crans, thus apportioned:—

December.	January.	February.	March.
—	530	177	25

No herrings were landed in November and December, according to the weekly returns, but at the end of the year 51 crans are added as having been landed between 3rd October and 26th December.

In 1904 the fishing began in the week ended 16th January, and small quantities of herrings were taken inshore at Dunure and Maidens. Towards the end of the month and in February fair takes were got in Loch Ryan; on 6th February a good "appearance" was reported on the banks, but little was taken, the total for the season being 875 crans, as follows:—

December.	January.	February.	March.
—	92	461	322

It also appears from a note that 108 crans were landed between 1st October and 31st December this year, but no particulars are given.

In 1905 there are unfortunately no particulars given as to the course of the fishing. It is only stated at the beginning of the summer fishing that 106 crans had been landed from 1st January to 27th May. There appears also to have been a good fishing towards the end of the year, because a note states that 2881 crans were landed between 1st October and 31st December, but there is no information as to the months otherwise, nor as to the localities where the fishing was carried on. The total for the whole year, including the summer fishing, was 4479 crans.

The fact mentioned, that there was a good fishing towards the close of

the year, probably indicated that the shoals were returning again to their old grounds, because the spring fishing in 1906 was better. In January a total of 584 crans were landed, but nothing is said as to the quantities each week, or as to the place of fishing. In the first part of February the fishing was apparently mostly about Loch Ryan; towards the end of the month, and in March, about the Ballantrae Banks. The fishing closed in the week ended 24th March, the total for the three months being as follows:—

January.	February.	March.
584	183	389

For the reason stated, the absence of information as to December, the total for the season cannot be given.

At the end of 1906 a very good fishing was obtained. In the early part of November good takes were secured near Ayr, and later in the month between Girvan and Turnberry, off Girvan, and in Loch Ryan. In December the fishing continued with extraordinary good results in Loch Ryan, but also between Ayr and Dunure, and at the middle of the month a good "appearance" along the whole coast was reported. In January the fishing fell off very much, and the herrings left Loch Ryan. The first part of February was stormy and few herrings were caught, the boats only fishing on two weeks in the month. March was also very stormy, and comparatively small catches were got on the spawning banks, the fishing closing in the last week of the month. The aggregate for the four months, December-March, amounted to 11,629 crans, by far the greater portion being got in December. If the catches in November are added the total would be 14,193 crans; but it is stated that most of the 69 crans landed in the first week of November were caught in other districts. It is to be noted in considering the monthly totals that seiners were excluded from the banks and within the area specified in the bye-law (*see* p. 48) from 15th January to the end of March; and in former years seiners landed the bulk of the herrings. The weekly particulars are these:—

November.		December.		January.		February.		March.	
Boats.	Crans.	Boats.	Crans.	Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
21	69	68	1,768	30	186	9	7	15	58
29	454	125	1,499	61	133	...	...	24	391
42	266	124	4,911	38	13	...	...	2	...
40	612	70	2,017	16	5	43	535	4	106
52	1,163	...	...	...	...	...	...	...	...
	2,564		10,195		337		542		555

From the above account it is evident that the fluctuations in the winter and spring fishing on the Ayrshire coast have been very marked over the period embraced in the records. Taking the mean for the whole period of all the herrings landed in the district, the yield in the years 1863–1874 was below the average; it was also below the average in the years 1892–1905, with the slight exception of 1901. It was above the average in the period 1877–1891, with the slight exception of 1886, and it was again above the average in 1906–1907. By far the greater quantity of

herrings is taken in the winter and spring fishing, and the curve for the whole year represents the yield of this fishing and its fluctuations very well. Judging from the curve (Plate III.), it is not improbable that the fishing during the next few years will be successful.

From the particulars as to the place of fishing, it would appear that in some years the predominant shoals approach the spawning grounds from the northwards, and in other years from the south: in still other years apparently from both directions, but full particulars are sometimes lacking. Thus, in the period 1865–1867 the shoals came from the north, as they did also in 1878, 1883, 1885, and in the period 1887–1891, and again in 1902 and 1903. They approached from the south in 1879–1882, apparently in 1904, and again last year. No doubt the banks off the coast are the spawning grounds for shoals of herrings that come from various quarters, and it may be from the Irish coast, which is only some 25 miles distant, and therefore much nearer than Loch Fyne. But in all probability the bulk of the herrings come usually from the Firth of Clyde.

*Campbeltown District.*

This district was formed in 1863, having previously been included in the district of Inveraray. It extends from Skipness Point down the eastern side of the peninsula of Kintyre, round the Mull, and along the western coast of the peninsula to Tayinloan, opposite the island of Gigha. It includes that island and also the islands of Islay, Jura, and Colonsay, in the first named of which an important herring fishery is carried on in some years. The statistics dealt with here are, however, practically confined to the herrings caught within the Mull of Kintyre—that is to say, within the Firth of Clyde. In 1906 there were in the district 358 fishing boats and 752 resident fishermen and boys, of which 159 boats and 475 fishermen belonged to the part of the coast from Skipness Point to Sanda Island, most of them being at the town of Campbeltown.

In the period 1863–1906, the gross quantity of herrings taken, and all practically in the Firth of Clyde, was 910,718 crans, or about 3,187,500 cwts., the general annual average being 20,698 crans. In the first twenty-two years, 1863–1884, the gross quantity landed was 317,939 crans, giving a general annual average of 14,452 crans. In the last twenty-two years, 1885–1906, the aggregate quantity landed was 592,779 crans, the general annual average being 26,944 crans. In this district, therefore, the quantity of herrings taken very considerably increased in the second half of the period.

Grouping the returns in ten-yearly periods, the mean catch per annum in each period was as follows:—

1857–66 ..	2,346 crans.	1887–96 ..	26,158 crans.
1867–76 ..	8,185 „	1897–1906 ..	26,503 „
1877–86 ..	29,286 „		

The first period embraces only four years, 1863–1866. When the returns are arranged in five-yearly periods, the resultant annual average in each period is as follows:—

1862–66 ..	2,346 crans.	1887–91 ..	34,852 crans.
1867–71 ..	4,958 „	1892–96 ..	17,465 „
1872–76 ..	11,413 „	1897–1901 ..	30,365 „
1877–81 ..	22,612 „	1902–06 ..	22,642 „
1882–86 ..	35,961 „		

The most productive period was thus 1882 to 1891, but an examination of the table showing the annual yield (p. 118), or the diagram of the same, shows that there were two great periods of abundance, viz., from 1879 to 1891, and from 1899 to 1903. The extent of the fluctuations in the annual yield was from 1732 crans in 1868 to 43,609 crans in 1882 and 43,535 crans in 1887. The catch in 1906 (11,070 crans) was the lowest since 1878.

The great area of fishing in the Campbeltown district is the Sound of Kilbrennan, an arm of the sea extending between the island of Arran and the peninsula of Kintyre, in a north and south direction, and having deep water—at some places over 80 fathoms. At the north end it opens into the area called the Inchmarnock waters, between Bute, Arran, and the mouth of Loch Fyne. It is up this stretch of water that the shoals of herrings often pass to the higher reaches, as Loch Fyne; but it would be wrong to consider the Sound merely as a passage-way to the northern waters, because dense shoals of herrings may be found in it throughout most of the year.

In the early years for which statistics exist the fishing in the district was comparatively poor. Thus for the years 1863-1868 the annual average was only 2192 crans, the highest yield being 2851 crans, in 1864. Particulars as to the place of fishing in those years are scanty, but it appears that the fishing was carried on chiefly in the neighbourhood of Campbeltown, and almost exclusively there in the early part of each season, the grounds extending to the south end of Arran. As the season advanced herrings were also taken up the Sound in the vicinity of Carradale, but by no means the bulk of the catch, and it is evident that in none of the years did a large body of herrings make its way up Kilbrennan Sound, or at least form the object of fishing there. Seining began in 1867, but it was not effective.

In 1869 and 1870 the catch was considerably greater, but it fell a little in 1871. The average for the three years was 7006 crans. In June, 1869, contrary to what occurred in the preceding years, most of the herrings were got near Carradale, or landed there, and there was said to be a good fishing all the way from Campbeltown to Skipness at the north end of the Sound. Thus in June, 1868, 214 crans were landed at Campbeltown and 139 crans at Carradale, while in June, 1869, there were 410 crans landed at Campbeltown and 695 at Carradale, about ten miles farther up the Sound. During the rest of the summer the shoals were chiefly about Carradale, and the drift-net was much more successful than the seine. The fishing closed on 9th October, the boats leaving for Greenock district. The total for the year was 7446 crans.

In 1870, the principal grounds were again about Carradale, and between it and the Arran coast, and drift-nets were chiefly used. At the end of September most of the boats were fishing at Loch Ranza, at the north end of Arran, the shoals having apparently "moved up towards Bute." During the rest of the year the fishing continued in this locality and also about Carradale. The fishing closed on 19th November, the total for the year being 8509 crans.

In 1871, by far the greater part of the herrings taken in June were caught in the vicinity of Campbeltown. On the 8th July, it is remarked that there was not much "appearance" of herrings near Campbeltown, but there was said to be a great body of herrings down at the Mull of Kintyre. During July, August, and September the best fishing was got about Carradale, and also in October, extending up to Skipness. The fishing closed on 21st October, the aggregate being 5063 crans.

The quantities taken in the various months of the two groups of years were as follows:—

	June.	July.	August.	September.	October.	November.
1863-68 ..	2,770	6,486	3,406	489	1½	—
1869-71 ..	3,962	5,951	7,615	2,473	893	124

In the years 1872-1874 the catches were above the average, the mean for the three years being 15,574 crans, and they were singularly uniform as to the gross quantity in each year. In these years, it may be here noted, the takes in Loch Fyne were abnormally low.

In 1872, the catch in June was comparatively small, and about equal quantities were landed at Campbeltown and Carradale; in July the fishing greatly improved, most of the herrings being taken about Carradale; in August it was also good, the fishing now extending up the Sound of Kilbrennan to Skipness; in September the grounds were the same, herrings being also taken near Campbeltown; and the fishing closed in October, in the week ended 26th, with an aggregate of 15,432 crans.

In 1873, the fishing in June was light, mostly in the lower reaches of Kilbrennan Sound, near Campbeltown, and Carradale, but also to the south of the island of Sanda, near the Mull of Kintyre. In August the fishing was chiefly in the Sound of Kilbrennan up to Skipness Point; it was the same in September and October. On the 18th October it was noted that herrings were abundant all along the western coast of Arran down to Pladda and up the Sound, between Carradale and Skipness. The fishing fell off afterwards, and it closed on 25th October, the total for the year being 15,891 crans.

In 1874, the Officer reported on 18th June that there was a good "appearance" of herrings at the Mull of Kintyre and all over the channel of the Firth of Clyde. In June the fishing was mainly in the lower reaches of Kilbrennan Sound, especially about Carradale and Campbeltown; in July the chief grounds were between Campbeltown and Carradale, but also all along the Sound between Campbeltown and Skipness. In August and September it was the same; in October the herrings were mostly found south and west of Carradale and towards the Arran shore. The fishing was continued in November, herrings being caught south-east of Davaar island, at the entrance to Campbeltown harbour, and it was reported that there were still plenty of herrings in the channel south of Arran. The fishing closed on 14th November, the aggregate for the year being 15,400 crans. As mentioned below, however, it appears that 484 barrels or crans were landed in the spring fishing of this year, which were not included in the totals. The quantities taken in the various months in the three years were as follows.—

	June.	July.	Aug.	Sept.	Oct.	Nov.
1872 ..	286	4,245	4,381	4,225	2,295	—
1873 ..	711	6,286	4,106	3,502	1,286	—
1874 ..	1,258	5,263	3,719	3,076	1,467	617
	2,255	15,794	12,206	10,803	5,048	617

The four following years—1875-1878—were much under the average, the lowest being 1875, when the yield was only 3064 crans, and the best 1877, when the aggregate was 12,081 crans. The average for the four years was 7876 crans.



In 1875 the fishing in June was probably far down the Sound, in the neighbourhood of Campbeltown, since 255 crans were landed there as against 182 crans at Carradale, whereas in the previous year 682 were landed at Carradale as against 470 at Campbeltown. In July the best ground was in the vicinity of Skipness Point; in August and September the Sound of Kilbrennan is given; towards the end of September the weather became boisterous, and the fishing closed in the week ended 9th October.

In 1876, the grounds are not mentioned in the records for June, but more herrings were landed at Carradale than at Campbeltown; in July the fishing was apparently chiefly in Kilbrennan Sound; in August mostly the Arran side of the Sound was productive; in September fishing went on from Carradale to Skipness, and at Loch Ranza, in the north of Arran, and it closed on 7th October, when the aggregate was 7275 crans.

In 1877, the fishing grounds in June are not stated, and almost as large a quantity was landed at Campbeltown as at Carradale. In July the fishing was in Kilbrennan Sound, particularly about Carradale; in August and September it was all over the Sound, and the season ended on October 6th. The total was 12,081 crans, more than half of which was taken in August.

The fishing in June, 1878, was chiefly about Carradale and Machrie Bay, and also with drift-nets at the south end of Arran; in July and August it was in Kilbrennan Sound, from Campbeltown as far as Skipness, but early in September the fishing fell off, and it ended for the season in the week ended 14th September, with an aggregate of 9085 crans. In those four years the aggregate quantity landed in each of the months was as follows:—

June.	July.	August.	September.	October.
4,523	10,284	12,987	2,848	64

The year 1879 was high above the average, the total quantity of herrings landed being 33,980 crans. The first entry in the records is dated 31st May, and it states that "the total catch from 1st January to 25th May is 3200 crans, and during last week 276 crans, making a total for the season of 3476 crans. Only in April and May were any herrings got." The Officer also states that the spring herring fishery had been the best on record. He says he found nothing recorded for the spring fishery before 1871, and he gives the following as the number of barrels or crans taken in the spring fishery of the succeeding years:—

1871	..	20 crans.	1876	..	1,667 crans.
1872	..	—	1877	..	536 "
1873	..	—	1878	..	952 "
1874	..	484 "	1879	..	3,476 "
1875	..	430 "			

These quantities fall to be added to the totals above given for the years in question, from the weekly records of which they are absent.

It is not stated where the fishing grounds were in April and May, when the herrings referred to were caught, but in the last week of May they extended between Carradale and Skipness, an unusual circumstance at that period of the year, and none were got at Campbeltown. Probably, therefore, the herrings this year made their appearance at an earlier date. In June the fishing was all over the Sound of Kilbrennan, principally near Carradale and Skipness, also in Machrie Bay, and some

drifters fished near Campbeltown. In July the fishing was also all over the Sound, there being a great "spread" of herrings, and drifters were more successful than seiners. The quality of the herrings, it was said, was better than for years. In August the quality of the herrings was "splendid," and no better fish were ever seen in the district. During this month and in September and October the fishing was still all over the Sound. On 1st November the Sound is described as still teeming with herrings, and boats came in great numbers from other districts. On 13th November it is reported that the fishing was between Campbeltown and Carradale, and that herrings were very abundant in the vicinity of Campbeltown. In the following week herrings were got in Campbeltown Loch and in Carradale Bay, and also between Arran and Kintyre. At the end of November the fishing fell off, but herrings continued to be caught near Campbeltown and Carradale till the second week in December, when the fishing closed. The quantities taken in each month, as far as recorded, were as follows:—

April and May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
3,476	1,127	5,131	3,781	4,172	8,646	7,526	121

In 1880 the spring fishing up to 22nd May yielded 5090 crans. The Officer states that the first herrings were got on 24th February; very few were landed in March; April was better; and in May, especially about the middle of it, the fishing was unprecedentedly successful. Nothing is said as to where the herrings were captured. In June and July the herrings were taken in the Sound between Campbeltown and Skipness, drifters and seiners being equally successful. On August 7th the Sound was described as swarming with herrings; in September the fishing fell off, the grounds still being from Campbeltown to Skipness, and towards the end of the month chiefly near Carradale apparently. In October the grounds continued the same, but drifters were less successful, as the herrings lay deeper, and the buoy ropes had to be let down from 12 to 20 fathoms before any herrings were secured. In November the fishing was all over Kilbrennan Sound; at the beginning of December it was chiefly about Carradale and the vicinity of Isle Ross; in the second week, chiefly about Clonaig, Crossaig, and Skipness, in the upper reaches of the Sound; in the week ended 18th it was mainly about Carradale and Isle Ross, and in the next week between Campbeltown and the south end of Arran; while a good "appearance" was still reported in Kilbrennan Sound. The total for the year amounted to 37,520 crans, apportioned as follows:—

24 Feb.—29 May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
5,120	2,330	12,073	5,426	2,579	2,584	2,625	4,783

In 1881 the aggregate for the year fell to 20,393 crans. The quantity taken up to the end of May was 1280 crans; no particulars are given as to the months or the place of capture. In June most herrings were got in the lower part of the Sound, but the fishing went on also between Carradale and Skipness; 2345 crans were landed at Campbeltown and 886 at Carradale, while in June, 1880, 1232 crans were landed at Campbeltown and 1098 at Carradale. In July the grounds were chiefly on the west side of the Sound, towards Campbeltown and about Carradale; at the end of August principally about Skipness. The fishing fell off in September, and continued light till the end of October. In November the herrings were secured in the upper reaches

of Kilbrennan Sound, more especially about Cour Bay and between that and Skipness. In December very good catches were got, and the fishing was mainly about Carradale. The quantities in the various months were :—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1,280	3,378	6,599	3,967	1,048	440	1,043	2,638

In 1882 the largest quantity recorded was landed, the total being 43,609 crans. No particulars are given as to the catch up to 31st May, except that the quantity was 2249 crans. In June the fishing was for the most part in the neighbourhood of Carradale and Campbeltown, the quantity landed at the former place, as far as specified, being 4586 crans, while 2298 crans were landed at Campbeltown. In July the grounds extended from Campbeltown up to and beyond Carradale, and towards the end of the month up to Skipness, where some of the seiners made heavy catches ; it is mentioned in the week ended 29th July that one seining crew earned £450 in three nights, and another £200 in one night. In August the fishing extended from Campbeltown to Skipness ; in September it was the same, but mostly from Carradale to Skipness ; on 21st October the upper parts of the Sound were described as swarming with herrings. The last herrings were landed in the week ended 28th October ; after this the weather was unsettled, and trials made were unsuccessful, and it was reported in November and again in December that the "appearance" of herrings had gone. The quantities in the various months were :—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
2,249	7,329	12,415	10,357	5,339	5,920	—	—

In 1883 the catch amounted to 36,465 crans, of which 1859 were taken up to 31st May. In June the fishing extended from Campbeltown to Skipness, and it so continued in July, August, and September, in the latter month especially from Carradale up to Skipness Point. In October it was the same, and towards the end of the month and in the early part of November, mostly about Carradale ; then (10th November) mostly from Carradale to Campbeltown, and later about Campbeltown. At the beginning of December the fishing was farther seawards on the south-east side of the Sound, and it came to an end on 8th December ; trials made in the week ended 22nd December were unsuccessful. The particulars for the months are these :—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1,859	3,267	5,980	7,695	3,312	7,122	5,751	1,479

The quantity taken up to 31st May in 1884 was 1766 crans. In June the fishing was mostly in the vicinity of Campbeltown and Carradale, but also all over the Sound, and at Cour. In July it was mainly between Campbeltown and Carradale, but also up to Skipness ; in August it was all over the Sound, and at the end of the month especially from Cour to Saddell and in Machrie Bay ; in September from Skipness to Saddell ; in October it was the same, as well as off Arran, in the vicinity of Pirnmill, and towards the end of the month heavy catches were got near Carradale. In November the fishing was mainly off Carradale and also at Campbeltown, and the season ended on 29th November, the boats leaving for the Ayrshire coast, where there was a

good fishing reported. The aggregate for the year was 33,572 crans, thus apportioned :—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1,726	2,363	8,672	5,799	925	9,654	4,393	—

In 1885 the aggregate was 36,812 crans, of which 2363 crans were caught before 31st May, time and place unspecified. In June the fishing extended from Campbeltown to Skipness, the seiners, as usual, working mostly in the upper waters, which are narrow, and the drifters in the lower reaches and near Campbeltown. In July the fishing was chiefly between Skipness and Saddell, and on the Arran side in Machrie Bay and between Pirnmill and Brown Head, towards Pladda. In August, on the west side of the Sound, it was mainly between Skipness and Isle Ross, and on the Arran side at Blackwater and Machrie Bay; in September it was chiefly from Skipness to Saddell, but also to the south end of Arran; in October it was on both sides of the Sound, especially about Carradale and Machrie Bay, and the herrings were said to be of prime quality. Towards the end of the month the best catches were got in the lower reaches and at Carradale, and the fishing closed on 24th October. Trials made after that were unsuccessful. The quantities in the various months were :—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
2,363	2,528	7,839	6,279	8,922	8,911	—	—

Up to 31st May, 1886, 4607 crans were landed. It is recorded that the "spread" of herrings was sometimes very great over Kilbrennan Sound, and that the chief fishing places were the entrance to Campbeltown Loch, near the Isle Ross, and Carradale, and "latterly" about Skipness. The fishing was chiefly in April. The fishing in June was about Carradale and Isle Ross and near Campbeltown; in July about Campbeltown, the lower reaches of the Sound, south of Arran, near Carradale, and Cour; in August all over the Sound on both sides; in September mostly in Carradale and Machrie Bay. In the earlier part of October herrings were taken in the upper parts of the Sound, near Crossaig and Cour, between Campbeltown and Arran, Machrie Bay, and also near Pladda; at the end of the month mostly about Carradale and Campbeltown and south of Arran; in November the fishing was near Carradale and in Machrie Bay, also off Davaar Island and on the south-west coast of Arran. In December it was mainly about Carradale and from Carradale to Saddell and Machrie Bay, and the season closed on 18th December. The total for the year was 29,318 crans, apportioned as follows :—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
4,607	2,075	2,684	4,319	2,684	2,045	3,114	7,790

In the closing week 5350 crans were landed, taken between Saddell and Isle Ross and in Machrie Bay, and the quality of the herrings was superior.

In 1887 the aggregate amounted to 43,535 crans, of which 6210 crans were taken before the end of May. In the Officer's published report\* it is said that fishing took place in every month of the year, and that

\* *Fifth Annual Report*, Part I., p. xlviii.

herrings were found in great abundance in Kilbrennan Sound in spring and summer. In June the fishing was not very successful; the grounds were in the mid-channel of the Clyde and from Sanda Island to Carradale, and it is noted that herrings were scarce in the Sound; later in the month they were got from Campbeltown to Carradale and at Cour Bay. In the early part of July they were caught near Sanda, in the channel of the Clyde, and in the Sound; about the middle of the month, chiefly in the Sound, from Campbeltown to Carradale, and near Cour and Skipness. In August the fishing was on both sides of the Sound, from Skipness to Carradale, and principally between Cour and Carradale; in September Carradale, Machrie Bay, and Cour were the chief localities, and at the end of the month between Carradale and Arran. In October the fishing was mostly near Carradale and in the lower reaches of the Sound, and at the end of the month near Brown Head, Arran, and southwards. In November it was also mainly in the lower reaches, at Machrie Bay, and then between Isle Ross and Carradale. In the early part of December it extended from Isle Ross to Crossaig and near Arran; then (week ended 10th) between Isle Ross and Davaar, and the lower reaches near Arran, and the fishing closed on the 24th December at Machrie Bay. The aggregate was thus apportioned:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
6,210	1,263	4,470½	3,330½	10,173	3,306	10,669	4,113

The quantity taken in 1888 up to the end of May was very large, viz., 10,884 crans. The Officer notes that the fishing was very successful in January and February, while from March to the end of May the catch was small. There is, however, some doubt as to whether the whole of the herrings were taken in the Clyde area, for the fishing at Islay had started in 1886, and was very successful in 1888, and it is possible that some of the herrings were taken there, but there is no information bearing on the point. In June the fishing was at Davaar and Sanda, and also at Campbeltown and Carradale, and it was not very successful. In July it was at first in Campbeltown Loch, the Clyde channel, and Kilbrennan Sound, and later all over the Sound and north of Carradale; in August the grounds were between Carradale and Saddell, and on the Arran coast; in September chiefly at Cour, Machrie Bay, and from Cour to Carradale; in October near Carradale and on the Arran coast, off Brown Head, and the lower reaches, and towards the end of the month at Isle Ross and Saddell; in November the fishing was in the lower reaches, and later near Skipness, Carradale, and Machrie Bay; in December it was near Campbeltown, Carradale, and on the south coast of Arran, and the season closed on the 29th December. The total for the year was 41,369 crans, apportioned as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
10,890	704	4,690	6,349	2,279½	4,702½	5,012	6,742

In 1888 an association, known as the Fishermen's Association, was formed by the fishermen of Inveraray, Campbeltown, and Rothesay districts, mainly with the object of sending their herrings by steamers chartered by themselves to the Glasgow market, but they also fixed a voluntary close-time to be binding on members from 15th March to 31st May. In 1889, accordingly, the 7534 crans taken before the 31st May were caught between 1st January and 15th March, and apparently all within the Clyde area. In June comparatively little was got in

Kilbrennan Sound, the fishing being mostly off Davaar and in the mid-channel of the Firth. In July it was mostly off Davaar and across to the Arran coast, also off Carradale; towards the end of the month and in August it was mainly off Carradale and between Carradale and Arran; in September it was off Carradale and at Pirnmill, Arran; in October near Carradale, near Pirnmill, and on the south coast of Arran; in November all over Kilbrennan Sound, and especially off Carradale and in Machrie Bay, and the same in December. The fishing closed on 28th December, the aggregate being 32,906 crans, apportioned as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
7,534	1,569	3,120½	2,620¾	2,392	5,572	8,162	1,936

In 1890 the quantity taken up to 31st May, and thus between 1st January and 15th March, amounted to 12,499 crans. The note of the Officer is:—"From 1st January to 15th March the herring fishing was prosecuted by most of the seine-net crews of the district, and were fairly successful and quality good." There is a little doubt as to whether or not herrings from Islay are included. In June the fishing was prosecuted off Davaar and Sanda and in the Sound, in the upper and lower reaches, and on the south coast of Arran. In July also in the Sound and the lower reaches, and most of the herrings were landed at Campbeltown. In August most of the herrings were taken about Carradale and Skipness, but the fishing fell off; in September it was very poor, and most of the boats left the district, fishing mostly about Ardlamont Point. In October it revived, and considerable quantities were taken near Skipness and in the upper parts of the Sound about Cour, and later about Carradale; in November the catches were got about Carradale, on the Arran coast, and at Machrie Bay, but the fishing fell off towards the end of the month, and in December very little was got, and that at Machrie Bay. The total for the year was 25,453 crans, thus apportioned:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12,499	1,157	3,527	156½	12	2,943½	5,053	105

In 1891 the aggregate was 30,998 crans, and the quantity landed before the end of May was the large one of 12,845 crans. The Officer's note is that the fishing from the beginning of January to the middle of February was "fairly good," and there is doubt as to whether all the herrings came from the Clyde. The fishing at Islay was still going on at the end of December, 1890, but on the other hand the Officer then noted (27th December) that there was said to be "a great appearance" in Kilbrennan Sound. In June the fishing was off Davaar, and south of it off Sanda, and in the channel of the Firth; also about Carradale and Machrie Bay, but most herrings were landed at Campbeltown. In July, while fishing still went on off Davaar, most were taken in Kilbrennan Sound, near Carradale, and in Machrie Bay; in August the fishing was off Isle of Ross to Carradale and from Carradale to Loch Ranza. Very little was caught in September, and then about Carradale, most of the boats going to other districts. In October the fishing was near Carradale, Machrie Bay, and south of the Sound. In November it was in Kilbrennan Sound, but little was caught, and none were taken in December. The quantities in the various months were as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12,845	4,119	9,976	2,408½	146	1,244½	359	—

For several years after this the fishing was under the average, and a summary may be given of the productive period, 1879-1891. In these thirteen years the lowest catch, in 1881, was 20,393 crans, and the highest 43,609, in 1882, the average for the whole being 34,305 crans, the aggregate catch in the period reaching a total of 445,960 crans. The average catch in each of the months was as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
5,592	2,554	6,706	4,806	3,383	4,853	4,124	2,285

The most productive month was thus July, followed by October, August, and November, there being a depression in September. July was the best month in four years and the second best in other two; August was the best in one year and the second best in five years; September was the best in one year and the second best in one year; October was the best in one year and second best in three years; November was the best in three years and second best in one year; December was the best in two years. Moreover, in the latter years of the period, from 1886 to 1890, the best month was November or December. The explanation is probably that on the whole the best catches are taken in the first part of the season, when the shoals are passing up Kilbrennan Sound, and then later when they are passing down.

In the years 1892-1898 the fishing was much less productive, the highest aggregate in any one year (1894) being 24,279 crans, and the lowest, in 1893, being 14,141 crans, the average for the seven years being 19,335 crans. The average catch in each of the months was:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
3,147	3,450	5,919	2,651	1,568	1,259	545	797

July was thus the most productive month, and after that June. In five of the seven years July was the best month, and in the other two June. The feature of these years was the preponderance of the catch in the earlier months and the slenderness in the later months of the season. Thus, the percentages of the yield in the three months, June-August, and in the three months, October-December, as well as in the period up to 31st May, are shown for the two groups of years thus:—

	To end May.	June-August.	October-December.
1879-1891	..	16	41
1892-1898	..	16	62

It will be seen that the average catch in the lean years is greater in June than it is in the productive years, and that for July is not much less, while the greatest falling off is in the later months of the year.

In 1892 the quantity taken up to 31st May was 2193 crans, apparently from Kilbrennan Sound chiefly. In June the fishing was off Davaar southwards and near Carradale; in July the same, and later in the month between Isle of Ross and Davaar and near Carradale; in August it was off Carradale, up the Sound, and at Machrie Bay; in September the fishing fell off greatly; in October it improved, the herrings being taken in the upper reaches near Cour and Skipness; in November it was prosecuted at Machrie Bay and near Carradale, and the last were caught at Carradale in the week ended 17th December, the aggregate for the season being 18,164 crans, as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
2,193	2,817	9,156	2,005½	37½	1,594	184	177

In 1893 the quantity up to the end of May was 3601 crans, the fishing as usual being in January and the first part of February. In June herrings were taken off Davaar, south of Arran, at Carradale, and at Cour. In July they were still procured in the lower reaches, off Davaar and Sanda, and the end of Arran, and in the Sound. In August the fishing was prosecuted in the Sound, and then it fell off, no herrings being landed in September, and only 3 crans in October. The fishing in November was again blank, no herrings being found in Kilbrennan Sound, but in December a few catches were got in Carradale Bay. The aggregate was 14,141 crans, as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
3,601	2,511	5,782	2,067	—	3	—	177

In 1894 the fishing somewhat improved, the total being 24,279 crans, of which 5000 crans were landed before the end of May, herrings being abundant in Kilbrennan Sound in January and February. In June the fishing was off Davaar, south end Arran, and especially in Kilbrennan Sound. In July it was in the lower reaches, also the Sound and near Carradale; in August in the Sound, particularly near Carradale; during the rest of the season it was in the Sound of Kilbrennan, so far as stated. The season closed on 4th November, trials made in the early part of December yielding no herrings; but the Officer reports on 29th December that a good fishing had started at Carradale, and that boats were going thither. The monthly quantities were as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
5,000	7,844	3,967½	4,903½	2,017½	543	4	—

No doubt the fishing in January was very successful, as the catch up to 31st May, 1895, amounted to 7115½ crans. A note states that of this quantity 1271½ crans were landed at Campbeltown, 783½ at Carradale, while 5060½ crans were shipped by buying steamers in Kilbrennan Sound. In June the fishing was off Sanda, near Campbeltown, at the south end of Arran and Kintyre, and in Kilbrennan Sound. In July it was much the same, while in August Kilbrennan Sound is alone mentioned. The fishing fell off after this, there being no "appearance" of herrings in Kilbrennan Sound in September, but in October, November, and December small takes were got in the Sound, and the total for the season was 15,765½ crans, apportioned as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
7,115½	1,596	4,514½	2,076½	40	125	118	180

The catch in 1896, before the end of May, was 2914 crans, but no information is given as to the place or months of capture. In June the fishing was on the Arran side, between Brown Head and Machrie Bay, and also from Davaar to Sanda. In July there is little information, but at the end of the month the herrings were taken chiefly about Skipness. This appears to have been the chief locality in August, and also 8–10 miles south of Davaar. In September the fishing was in Kilbrennan Sound, especially between Carradale and Skipness; in August it was the same, and between Pirnmill, Arran, and Machrie Bay; in November at Machrie Bay and on the Arran side, and in December the same, and near Carradale. The total for the year was 14,973 crans, as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
2,914	2,177	3,380	2,104	1,109	2,457	460	392



The quantity taken in 1897 was considerably greater, totalling 24,202 crans, of which only 393 crans were caught before the end of May. There is not much information as to the places of fishing in June, but at the end of the month the best fishing was between Sanda and Davaar. In July there were heavy takes in Kilbrennan Sound, particularly off Skipness, but also down as far as Campbeltown; but many of the boats went to Loch Fyne, where there were dense shoals of herrings. In August and September the fishing in the district was between Skipness and Carradale, and off Skipness; it was much the same in October, but then also at Machrie Bay, but the fishing fell off towards the end of the month. In November the herrings were still scarce in the Sound, and those obtained were got near Skipness, and, later, between Carradale and Pirmill. In December the fishing continued poor, and it closed on the 25th. The monthly catches were as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
393	788	9,692	3,621	5,001	3,706	937	64

It is evident that the great shoals which had been in Loch Fyne this summer did not leave the region by Kilbrennan Sound, and the same conclusion may be drawn from the comparatively small quantity taken in 1898 up to the end of May, viz., 816 crans. In June of this year a large quantity of herrings were taken, the grounds being in Kilbrennan Sound, especially from Carradale to Skipness. There is no information given as to the place of fishing in July; in August it is only mentioned in the last week, when it was said to be at Skipness; in September it was between Machrie Bay and Carradale, and from Skipness to Machrie Bay; in October from Skipness to Carradale; in November at Machrie Bay; in December the best places were in the upper parts of Kilbrennan Sound, between Cour and Clonaig; later in Ardnacross Bay, near Campbeltown, near Carradale, and in Machrie Bay. At the end of December fishermen reported a "splendid appearance" of herrings on the coast. The aggregate quantity for the year was 23,817 crans, thus apportioned:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
816	6,421	4,937	1,780	2,771	387	2,116	4,589

With the revival of productive fishery at the end of the year the catches began to increase, and from 1899 to 1903 they were much above the average. The total quantity landed in these five years was 171,582 crans, giving an annual average of 34,316 crans, thus apportioned:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
4,504	4,070	8,068	9,493	4,607	1,360	942	1,271

Thus, 13 per cent. were taken up to the end of May, 63 per cent. in June–August, and 10 per cent. in October–December. In four of the years the best month was August, in the other year it was July, and in three years the second best month was July, in one it was August, and in the other September.

In 1899, the quantity taken to 31st May was 4120 crans; no information is given as to the localities or time of capture, and the information in most of the year is meagre. In June the herrings taken in the week ended 10th were secured near Carradale and Machrie Bay; in July those got in the week ended 22nd were taken in the Sound; in August the fishing was all over the Sound; in the week ended 16th September

the fishing was also in the Sound, and probably during the rest of the month. On October 7th it was reported that there was a good "appearance" in the Sound; on 14th the fishing was best at Machrie Bay, and nothing was caught from this date until 17th November, chiefly, it would appear, from bad weather; the place of fishing is not mentioned. In the week ended 25th November heavy catches were secured close in on the Kintyre coast, and the shoal extended from Kildalloig Bay (immediately to the south of Davaar island) to Isle Ross, about four miles north of Davaar. At the beginning of December there was a good "appearance" about two miles north of Davaar; stormy weather came on, and trials made in the middle of the month were blank; it was believed the herrings had gone into deep water. On 23rd December a good "appearance" was reported between Carradale and Skipness, and in the last week of the year 178 crans were taken off Brown Head, Arran. The aggregate for the year was 31,898 crans, thus apportioned:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
4,120	4,259	6,049	6,939	6,135	1,488	2,717	191

The quantity caught up to the end of May, 1900, was 3994 crans. In June the fishing was in Kilbrennan Sound, and best between Carradale and Machrie Bay, and close inshore between Carradale and Campbeltown. In July it was between Saddell and Clonaig, and near Carradale; in August (when over 11,000 crans were landed) it was in the first week chiefly at Machrie Bay and near Saddell, then on the Arran shore between Machrie Bay and Pladda, and then in the vicinity of Skipness, Machrie Bay, and Carradale. In September the fishing was general over the Sound, best takes being got near Carradale, off Cour, and between Carradale and Pirnmill. In October the fishing was mostly in Machrie Bay and near it, and the herrings were said, towards the end of the month, to be gradually moving southwards. Very little was taken in November, though the weather was usually favourable for fishing; most were secured near the end of the month, close into the shore about four miles north of Campbeltown. It was then reported that there was a "splendid appearance" of herrings from Carradale to Campbeltown, but the weather in December was mostly boisterous, and those taken were secured in the week ended 8th, locality not mentioned, but it is said the herrings were making for the spawning ground off Brown Head, Arran, and that the milt and roe were very ripe. The total for the year was 40,557 crans, as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
3,994	4,297	6,962	11,355	8,896	4,101	610	342

The fishing in the early months of 1891 was apparently good, for the quantity landed up to 31st May was 6097 crans. In June the grounds were, in the first week, on the Arran shore between Pirnmill and Machrie Bay, and in the last week near Cour, about midway between Carradale and Skipness. In July the fishing was between Carradale and Campbeltown, and on the Arran side, especially in Machrie Bay. In August it was in various places in Kilbrannan Sound, as Machrie Bay and near Carradale. In September, when 3241 crans were taken, there is no information; in the first week of October 864 crans were landed, after which the fishing fell off, the boats failing to get herrings; very little was got in the first part of November (at Clonaig and Carradale), but towards the end of the month some good takes were secured in

Ardnacross Bay, a few miles to the north of Campbeltown; in the early part of December (in which month 2406 crans were landed) the herrings were got in the same neighbourhood, and later on in Machrie Bay. The total for the year was 31,349 crans, as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
6,097	3,721	6,261	7,648	3,241	894	1,081	2,406

In 1902, the quantity taken up to the end of May was 3881 crans. In June the fishing was in Machrie Bay, at the south end of Arran, from Pirnmill to Brown Head, and at Cour Bay. In July, when 11,980 crans were landed, the fishing in the first week was mostly off the south end of Arran and at Cour, then between Carradale and Skipness, then on the Arran shore, and in the last week between Skipness and Carradale; the herrings were inferior, and largely small fish. In August the fishing was chiefly between Skipness and Carradale. This was also the case in the first two weeks of September, after which the fishing fell off, herrings getting scarce. Very little was got in October, and nothing from the Sound in November, the boats fishing chiefly in another district, between Garroch Head and the north of Arran. December was also blank until the week ended 27th, when 287 crans were taken in Saddell Bay, and in the closing week of the year 824 crans were caught between Saddell and Davaar. The total for the year was 38,016 crans, as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
3,881	4,895	11,980	11,727	4,071	317	30	1,115

From 1st January to 31st May, 1903, the quantity landed was 4430 crans. In June the fishing was mostly in Machrie Bay, near Carradale, at Skipness, Cour, Ross Isle, and Davaar. In July there is only information for the first week, when 962 crans were secured, mostly at Cour, Carradale, and Machrie Bay. After the first week in September the fishing fell off, and no herrings were landed from Kilbrennan Sound between the early part of September and the week ended 28th November, when 272 crans were got in Kildalloig Bay, near Campbeltown, and the herrings are described as very large, and full of milt and roe. In December, when 2301 crans were caught, the herrings were chiefly got between Isle Ross and Carradale, in Ardnacross Bay, Machrie Bay, and neighbourhood. The herrings were very large, running about 650 to a cran, very ripe, and some of them were spent. The aggregate quantity for the year was 29,762 crans, apportioned as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
4,430	3,180	9,088	9,797	694	--	272	2,301

In the years 1904–1906 the catch of herrings fell considerably. In the three years the aggregate quantity landed was 45,434 crans, the annual average being 15,145 crans. The averages for the various months were as follows:—

To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
4,939	2,609	4,387	2,496	318	85	47	263

The percentage up to 31st May was 33; for the three months June–August 63, and for the three months October–December, only 2·6. In each year July was the best month.

In 1904, 5872 crans were taken up to 31st May, but no information is given either as to the localities where the herrings were caught or the months. In June the fishing was chiefly near Carradale, at Machrie Bay, and between Skipness and Carradale. In July the herrings were mainly caught in Kilbreunan Sound, north of Carradale, Isle of Ross, and at Davaar; in August in Kilbrennan Sound; in September near Brown Head, Isle of Ross, and along the Arran shore. In October the fishing fell off; nothing was got in the Sound, what was landed being obtained between the islands of Pladda and Sanda, and between Pladda and Ailsa Craig. In November two crans got at Carradale represented the whole catch; they were taken in the week ended 26th. In December, with the exception of two crans taken in Carradale Bay at the beginning of the month, nothing was got until the week ended 21st, when 377 crans were caught in the vicinity of Isle Ross and Davaar, while in the next week 306 crans were secured at the same places and at Kildalloig Bay. They are described as fine large herrings, nearly ripe. The total for the year was 12,906 crans.

In 1905 the quantity landed between 1st January and 31st May was 5384 crans. In June the fishing was from Machrie Bay to Brown Head, then Carradale to Campbeltown, and later, from Crossaig to Torriedale, and Cour to Isle Ross. The fishing was chiefly from Carradale to Skipness, along the Arran shore, off Brown Head, and from Davaar to Pladda. In August it was in the Sound, and off Davaar and Pladda. In September only six crans were landed, five in the first week off the Arran shore, and most of the local crews had gone to the Ayrshire fishing. In October the herrings landed were mostly from other districts; but in the week ended 25th November, 64 crans were got at Ardnacross Bay, near Campbeltown, the herrings being described as large and full of milt and roe, none being spent. In December they were obtained in the same locality and at Isle Ross, but no large catches were secured. The total for the year was 21,458 crans.

In 1906 the quantity up to the end of May was 3562 crans. In June the fishing was good between Machrie Bay and Brown Head, and from Skipness to Davaar; in July the herrings were caught midway between Arran and Kintyre, between Carradale and Skipness, and near Davaar. In August the fishing fell off, herrings being got in small quantities in Machrie Bay and in the Sound. In September no herrings were taken till near the end of the month, on the Arran shore. In October only five crans were taken in the first week; and in November there was no fishing. In December only five crans were got in Kildalloig and Carradale Bays. The total for the year was very small, viz., 11,070 crans. In the three years the quantities taken were apportioned as follows:—

		To end May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1904	..	5,872	1,550	1,938	1,772	869	218	2	685
1905	..	5,384	2,886	7,737	5,175	6	32	138	100
1906	..	3,562	3,392	3,486	541	79	5	—	5

Last year the catch was the smallest since 1878.

#### *Inveraray District.*

The limits of this district comprise the coast, lochs, and islands between Oban and Tayinloan, on the west side of Argyllshire, but the important area is Loch Fyne, within Ardlamont and Skipness Points. The herrings

got elsewhere in the district are small in quantity, and the statistics dealt with, as before explained, represent substantially the product of the Loch Fyne fishery. The district included that of Campbeltown until 1863, when the latter was separated from it.

The gross quantity of herrings taken in Loch Fyne during the forty-four years, 1863-1906, amounted to 1,107,926 crans, giving an annual average of 25,180 crans. In the first twenty-two years, 1863 to 1884, the aggregate quantity of herrings landed was 505,702 crans, giving an annual average for the period of 22,986 crans. In the last twenty-two years, from 1885 to 1906, the aggregate quantity was 602,224 crans, giving an annual average of 27,375 crans. In the second half of the period there was thus an excess of 96,522 crans over the first half, the average increase per annum being 4,389 crans.

When the annual statistics are arranged in ten-yearly periods we have the following annual averages:—

(1857-66	..	22,567)	1887-96	..	30,943
1867-76	..	20,255½	1897-1906	..	24,889
1877-86	..	25,679½			

The averages when the figures are arranged in five-yearly periods are:—

(1862-66	..	22,567)	1887-91	..	30,201
1867-71	..	29,732	1892-96	..	31,685
1872-76	..	10,779	1897-1901	..	36,719
1877-81	..	21,053	1902-06	..	13,059
1882-86	..	30,306			

The annual fluctuations in the annual yield of the herring fishery in Loch Fyne have been great, ranging from a minimum of 3648 crans in 1873, 4806 in 1874, and 4672 in 1905, to maxima of 55,754 crans in 1882 and 56,820 crans in 1897. If we take the mean annual yield over the whole period, then the following years were under the average:—1863, 1864, 1871-1880, 1884, 1886-1888, 1895 and 1896, 1900, and 1903-1906. The periods of greatest scarcity were from 1872 to 1875 and 1904 to 1906. The most productive years were:—1867-1869, 1881-1883, 1890-1894, and 1897-1899.

The physical features of Loch Fyne will be fully dealt with later, but it may be said here that the loch is divided into two well-marked portions—a lower and wider part, extending from Ardlamont and Skipness Points to Otter Spit, where the water is almost everywhere deep, reaching 70, 80, and in some parts even 100 fathoms; and an upper and narrower part, commonly called Upper Loch Fyne, extending from Otter Spit to the head of the loch. This again may be divided into two parts, the lower, from Otter Spit to the vicinity of Furnace, being as a rule under 30 fathoms, while the upper part is generally much deeper, and may be over 70 or even 80 fathoms.

With regard to the fishing each year in the loch, it is chiefly important, if possible, to distinguish the productiveness of the upper and the lower lochs, and for a number of years the records enable this to be done.

In the earlier records, from 1854 to 1863, before the Campbeltown district was separated, notes are occasionally given throwing light on the fishing in Loch Fyne, and some extracts may be cited. In 1854 the first entry is in the week ending 1st July, and in that year there was a fishing in the upper loch, and apparently a good one. In August and October large catches were got from Skipness to Otter Spit; in November the fishing was chiefly about Skipness and Laggan, and down to Carra-

dale ; and in December good takes were got at Skipness, the herrings being large fish, running about 600 to a cran.

In 1855, the first entry is 16th June, but 1326 crans were caught from 1st January to 9th June in the district. It is stated that the herrings appeared in the loch earlier than was expected, and the fishermen were scarcely ready for them. In June the fishing was chiefly from the head of the loch to Otter, but also at Ardlamont and Tarbert. In July the fishing was very good in the upper loch, especially about Inveraray. In October, November, and December seiners were very successful about Skipness, the herrings being large and full of milt and roe.

In 1856, the first entry is 21st June ; 1178 crans were caught in the district between 1st January and 14th June. Until August the fishing in the upper loch was poor ; in November large quantities were taken at Ardlamont, and in December at and above Otter Ferry, and at Skipness.

In 1857, 1716 crans were landed in the district from 1st January to 13th June. In June some very large herrings were taken near Tarbert, those caught by the seine selling for 28s. 6d. for 120 fish, those taken by drift-net at 24s. per 120, and the lowest price was 14s. Here it may be mentioned that in those years the prices appear to be much higher, there being little competition comparatively on the East Coast. At Tarbert, in December 1854, cured herrings sold at 45s. a barrel. In July, August, and September the best fishing was in the upper loch, particularly at Inveraray, and the buoy ropes of the drift-nets in the latter month were 60 fathoms long, so that the herrings were in the deep water. In October the fishing was also largely up the loch, and in November good takes were got at Crarae.

In 1858 3000 crans were landed up to 26th June. In June and July the fishing up the loch was light, but from August to the end of the year it was chiefly in the upper loch, from Minard to Inveraray. Seiners flocked thither, and riots occurred between them and the drifters.

In 1859, 3209 crans were landed to June 11th. In July and August the fishing in the upper loch was good ; it fell off in September and October, but revived towards the end of November, especially about Minard, and 400 boats were fishing in the upper loch. It continued remarkably good in December, large quantities being caught about the middle of the month near Minard and Loch Gair, and towards the end in the lower loch, especially at Inverneil Bay, near Ardrishaig, and from there towards Tarbert. Some of the seiners got 200 crans in a haul, and about 500 boats were fishing in the lower loch.

In 1860 the Officer begins his record in January, in which month good catches were obtained by the seiners, but the fishing fell off towards the end, chiefly from bad weather, as large shoals were said to be in the lower loch and at Loch Gair. In February the fishing continued at Inverneil, the herrings being large, but many of them were spent. In March they were mostly spent, and the fishing extended to Skipness and Carradale ; at the end of the month they were all spent. It thus appears that in the early months of 1860 a shoal of herrings spawned in the neighbourhood of Inverneil. In April little was done ; at the end of May fishermen reported that they never had seen such an abundance of herrings in Loch Fyne at that period before. In June the fishing was apparently only in the lower loch ; in July there was a light fishing in the upper loch, which improved in August and September. In October the fishing was chiefly between Otter and Tarbert, especially at Inverneil, also at Minard. In November the fishing was very successful between Otter

and Tarbert (10,460 crans were landed in the district this month), and also in December between Ardlamont and Otter, and also at Inverneil and Loch Gair. The Officer now began to detail the catches, and the following for the weeks in December may be given :—

Week ended	Drift-net.		Seine-net.		Total.	
	Boats.	Crans.	Boats.	Crans.	Boats.	Crans.
8th ..	178	350	38	1,600	208	1,950
15th ..	180	350	48	2,100	228	2,450
22nd ..	150	380	40	2,050	190	2,430
29th ..	70	60	15	600	85	660
		1,140		6,350		7,490

From 1861 to 1876 the Officer noted the quantity taken in Upper Loch Fyne in each month of the year, which I have extracted in the accompanying Table.

TABLE showing the Number of Crans of Herrings taken in Upper Loch Fyne in each month of the years 1861-1876.

	1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875	1876
January ...	...	...	...	...	...	...	85	505	...	670	...	...	...	...	10	30
June ...	30	4	16	58	17	14	41	85	35	190	680	46	80	20	42	64
July ...	210	203	68	183	410	45	516	1015	1643	275	459	27	105	23	45	12
August ...	455	500	2115	1017	1620	2080	2542	800	723	273	11	7	...	11	...	...
September	132	?	2420	1195	2346	1160	551	2331	1640	81	17	3	...	8	...	...
October ...	457	8615	1313	461	917	1578	553	2245	148	30	...	...	...	...	...	...
November	331	6730	2719	254	125	554	1970	100	4	35	5340	...	...	...	...	...
December	1120	4303	857	6	275	155	335	150	900	53	...	50	...	...	5	...
Total ...	2735	?	9505	3174	5710	5580	6593	7231	5093	1607	1172	473	185	62	102	106

It will be seen that in the years 1862-1869 large quantities of herrings were taken in Upper Loch Fyne, particularly in 1862 and 1863, and that after 1869 the quantity declined to a marked extent. This Table, however, represents the minimum, because many of the herrings landed at Ardrishaig were caught in the upper loch.

In 1861 the fishing in June was poor, and best at Minard; in July there was also little fishing in the upper loch, and again in September; in October the best fishing was at Inverneil, and then from Kiltinan to Ardlamont. In November the Officer remarks that there had been very little doing in the upper loch the whole season, and though the fishermen reported that there were abundance of herrings from Tarbert to Furnace they could not catch them. In December the fishing improved, especially between Minard and Furnace.

1862 was a very productive year, the total for the district (including Campbeltown) being 57,361 crans. From the records it appears that the approximate quantity taken in Loch Fyne was about 52,400 crans,

the greater proportion of which was taken in the upper loch, and the best months were October and November. Until the end of July the fishing was light, especially in the upper loch; in the last week of the month the best fishing was between Inverneil and Skipness. In August it greatly improved both in the lower and the upper loch. In September it continued very productive, especially between Otter and Minard. In October as many as 550 boats were fishing in the upper loch, the best grounds being at the top, off Cairndow, and later from Furnace to Loch Gair. At the end of November there were 660 boats, and the best fishing was about Minard. During December the fishing was mostly from Minard to Loch Gair, and towards the end of the month also off Inverneil. When the season closed herrings were still abundant in both the upper and the lower loch, but no fishing took place in the early months of 1863, owing to the close time.

In 1863 the aggregate for Loch Fyne was 22,923 crans, and the fishing in June was poor. In July it improved, and was chiefly in the lower loch. In August it was much more productive in the upper loch about Inveraray; in September the fishing was chiefly from Furnace to the head of the loch; in October 530 boats were fishing in the upper loch; in November the best grounds were at Minard and then Minard to Loch Gair. In the early part of December good takes were obtained at Inverneil as well as above Otter, but the fishing fell off, and towards the end of the month the herrings were said to have left the loch.

In 1864 the herrings were chiefly taken in June in the lower loch; in July the best fishing was between Otter and Maol Dubh (between Tarbert and Ardrishaig); in August it greatly improved in the upper loch, and was good there in September, but after this it fell off in the upper loch, and in November and December little was got in Loch Fyne. The total for the year was 12,867 crans.

The yield from 1865 to 1870 was above the average, 1868 and 1869 being the best.

In 1865 the total was 26,118 crans, of which 5710 crans were secured in the upper loch. In June very little was caught; in July it improved towards the end of the month, but was still unimportant in the upper loch. In August most of the herrings were got in the lower loch, and the fishing in the upper loch was better; in September most were taken near Tarbert and Ardrishaig, and 2346 crans in the upper loch, in October the fishing was less successful, the herrings being mostly taken in the neighbourhood of Ardlamont; in November little was caught in the upper loch, those landed being chiefly got about Ardlamont. Towards the end of November the fishing fell off, and most of the boats went to the Kyles of Bute; in December very little was caught.

In 1866 the aggregate was 28,360 crans, of which 5580 were taken in Upper Loch Fyne. In June very little was caught, and chiefly about Otter. In July 45 crans were taken above Otter, after which the fishing improved in the upper loch, but throughout the year most were caught in the lower loch, the places not specified.

In 1867 the aggregate catch was 34,415 crans, of which 6593 crans were taken in the upper loch. In January 85 crans were got at Minard. In June the fishing was light; in August, when 13,456 crans were landed, most were got in the lower loch, the chief grounds being from Tarbert to Otter Spit, and 2542 crans were taken in the upper loch; in September most were taken in the lower loch, and also in October. In November most of the herrings were secured between Furnace and Loch Gair and Otter. In December the shoal moved farther down and good



takes were obtained between Loch Gair and Otter, and at the end of the year a great shoal was reported to be in the upper loch.

In 1868 the aggregate for the year was 39,795 crans, of which 7231 crans were taken in the upper loch. In January 3038 crans were landed, 505 from the upper loch, and nearly all the rest were landed at Ardrishaig. In June the fishing was chiefly between Skipness and Otter Spit, very little being got in the upper loch. In July the fishing was very general all over the loch from the top of it to Skipness, and it continued thus till the latter part of October, some heavy catches with seines being got in October, near Inveraray. In November little was taken in Loch Fyne, the boats mostly leaving for Greenock, where a very good fishing was reported. In December the herrings were taken at Minard, but chiefly on the Cowal shore in the lower loch, and at the end of the month there was no "appearance" of herrings in Upper Loch Fyne, and it was believed the shoals had left.

From this year the productiveness of the fishing in Loch Fyne declined steadily to the year 1873, when it reached its lowest point.

In 1869 the aggregate catch amounted to 34,024 crans, of which 5093 were got in the upper loch. In January 763 crans were caught on the Cowal shore and about Ardlamont Point. In June the fishing was in the lower loch, little being caught above Otter till the end of the month, and then at Inveraray. In July the fishing improved in the upper loch, and a good "appearance" was reported from Skipness to Inveraray. In August the herrings were most plentiful about the mouth of the loch, and this was the case also in September. In October the fishing fell off in both upper and lower lochs, what was got being taken near the mouth of Loch Fyne and Ardlamont; towards the end of the month many boats left for Greenock, though a good "appearance" was reported between Tarbert and Ardrishaig. In November the fishing declined still further. In December the fishing revived, especially in the upper loch, where some heavy takes were secured.

In 1870 the quantity landed was 26,909 crans, of which 1607 were taken in the upper loch. The upper loch was thus the first to be affected in the decline of the period. In January a total of 935 crans were landed, of which 670 crans were got above Otter, and chiefly about Minard, and the rest were landed at Ardrishaig. The fishing in June was good, and all over the loch, but less was taken above Otter. In July and August nothing is said about the fishing grounds, but the catch in the upper loch was small. In September and October the fishing was at the mouth of Loch Fyne, and about Skipness and Ardlamont; this was also the case in November, though in this month the shoal shifted for a short time to Kilfinan Bay, where good takes were got. In December some were got at Loch Gair, but most of those taken were caught at the mouth of the loch.

In the six years, 1865-1870, all above the average, the aggregate quantity of herrings taken was 189,621 crans, giving an annual average of 31,603 crans. They were thus apportioned, the figures representing the average catch:—

Jan.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
858	1,923	4,854	9,255	6,777	4,878	1,908	1,149

The percentage taken in January was 2·7, in June–August 51, and in October–December 25. In three of the years August was the best month, and in one each July, September, and October.

All the years 1871-1880 were below the average, and the quantities taken in the years 1871-1875 were especially small.

In 1871 the aggregate was 13,515 crans, or about half of what the catch was in the previous year; of this quantity only 1172 crans were taken in the upper loch. In January, 1840 crans were taken, all about Skipness and the upper part of Kilbrennan Sound, where a shoal was reported to be. On 3rd June it was reported that herrings appeared to extend all the way from Skipness to Furnace, and in this month 3415 crans were taken, the best of the year, of which 680 were got in the upper loch; at the end of the month a prosperous season was anticipated. In July the herrings were scarcer, and at the end of the month the fishermen were getting discouraged, and they blamed the heavy rains for having driven the herrings away, or into deep water. In August it was still more disappointing, the fishing being, as it had been from the first, chiefly between Tarbert and Skipness, towards the mouth of the loch, and the fishermen did not remember a season when herrings were so scarce in the loch. In September the fishing was only about Skipness, the total for the month being 717 crans. In October it improved, but was still only at the mouth of the loch. During the rest of the year few herrings were caught in Loch Fyne, most of the fish in November and December being taken about Skipness and the adjacent part of Kilbrennan Sound.

In 1872 the aggregate was less, viz., 9057 crans, of which 473 were got in the upper loch. In January trials were made, but no herrings caught. In June only 715 crans were landed, nearly all from Skipness; it was the same in July, the fishing being at Skipness and up to near Tarbert. In August also nothing was got, except about Skipness and in Kilbrennan Sound; "there is nothing to be got in Loch Fyne," said the Officer on August 6th, "but a few mackerel." In September and October such fishing as there was was about the mouth of the loch, at Skipness and Kilbrennan Sound, occasionally at Ardlamont. In November an improvement took place, and herrings were caught from about Ardlamont to above Otter, and in the next week (ended 23rd) part of the shoal had got up to Minard, and in the last week of the month good hauls were got from Tarbert to Minard. In the early part of December the fishermen said the herrings had left the upper loch and moved rapidly towards Skipness and Kilbrennan Sound, and 700 crans were taken in the first week. After this only a few were got at Skipness.

In 1873 the total for the year sank to 3648 crans, the lowest in all the records, and of this 185 crans were got in the upper loch. There was no "appearance" of herrings in January. In June and July the fishing was poor, those got being obtained mostly near Tarbert. In August only 134 crans were landed, and most of them it would appear came from Kilbrennan Sound. The same conditions prevailed during the rest of the season, most of the boats which continued the fishing doing so in Kilbrennan Sound, returning at the end of the week, and most of the herrings landed in September and October came from other waters apparently. There was no fishing after October, and meetings of fishermen were held at Ardrishaig complaining of seining, which, it was believed by many, was a cause of the dearth.

In 1874 the aggregate for the year was but little higher, namely, 4806 crans, of which 62 were obtained in the upper loch. No trials were made in January, and there is no record of any "appearance" of herrings. In June, trammels were tried at various places in Upper Loch Fyne, and a few herrings were got all the way up to Inveraray; some

herrings were also taken between Kilfinan and Maol Dubh, in the lower loch, and near Tarbert. At the end of the month it was reported that there was an abundance of very small herrings between Otter Ferry and Cranae. In July the fishing was at the mouth of Loch Fyne, and as many mackerel as herrings were taken. In August only 917 crans were landed, some of which were got at and near Skipness, but apparently the greater proportion in Kilbrennan Sound. In September, and until the close of the season, the boats fished mostly at the mouth of the loch and in Kilbrennan Sound; in November a few crans of very small herrings were caught at Inverneil.

The aggregate for 1875 was much better, reaching 13,546 crans, of which 102 were obtained in the upper loch. In January ten crans were landed, all caught in the upper loch, near Minard, and they were very small fish, running from 1600 to 2000 to a cran. The catch in June was very small, only 650 crans, and the herrings were taken mostly near Skipness also on the Cowal shore, and on both sides of Otter Spit and near Minard. It was reported that there was abundance of small-sized herrings in the upper loch. In July the catch rose to a total of 5675 crans, nearly all caught between Skipness and Tarbert, and they were mostly large and fine fish; only 45 crans were taken in the upper loch, and the herrings were small. In August 4069 crans were taken, mostly near Tarbert and between Tarbert and Ardrishaig, and the Officer notes that the herrings were further up the loch than they had been for some years. The total in September was only 425 crans, though the weather was fine, and the herrings were very small and inferior. The fishing improved in October, when 1202 crans were secured, most being apparently got about Skipness, but the place is not always stated. The catch in November was a little higher, viz., 1215 crans; most of them were taken in the first week near Tarbert. In the week ended 27th, the weather being favourable, a thorough search was made, but only 30 crans were got, and it was believed the shoals had left. On the other hand, great quantities of herring fry, measuring from  $1\frac{1}{2}$  to 2 inches, were about Otter Spit, as many as from 15 to 20 being got in the stomach of coalfish which were caught there. At the beginning of December a small shoal struck in near Laggan, and during the month 295 crans were taken there, and between it and Tarbert. In the last week of the year five crans of very small herrings were taken in the upper loch, ranging from 1600 to 1800 to a cran. A feature of the year was the abundance of very small herrings in Upper Loch Fyne, and in the lower loch also the quality was usually very mixed, small fish often predominating.

In the five years 1871-1875, the gross quantity of herrings landed was 44,572 crans, giving an annual average of 8914 crans, thus apportioned:—

June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1,308	2,588	1,900	788	939	786	232

The percentage for the months June-August was 65, and for the months October-December, 22.

In 1876 the aggregate for the year was nearly up to the average, viz., 22,836 crans, and only 106 crans of this, so far as the records go, were taken in the upper loch. The detailed records, however, stating the quantity taken in the upper loch in each week come to an end in July this year, and it is probable that the quantity taken there was greater. On 15th January a trial made with the seine-net at Kilmichael Beg in the upper loch resulted in a body of herrings being enclosed, but only thirty

crans were secured; trials later in the month at Minard were blank. In June some were taken in Upper Loch Fyne, and the fishermen reported a good "appearance" there. In July there is little information, but on 22nd it is noted that the herrings are widely spread from a little above Otter Ferry to Skipness and Ardlamont. In August the fishing was all over the lower loch, especially between Tarbert and Skipness; in September it was chiefly about Ardlamont and Skipness. In October nearly all the herrings were landed at Tarbert; in the week ended 28th no less than 5300 crans were caught about Skipness, and the quality was good, the number of herrings to a cran ranging between 700 and 900. In November a large body of herrings still remained about the mouth of the loch, most being taken between Skipness and Tarbert, and about Skipness. None were caught in December, the shoal having gone down Kilbrennan Sound.

In 1877 the aggregate catch fell to 19,618 crans. There was no appearance of herrings in January, and some trials which were made were unsuccessful. In June, when 2614 crans were landed, herrings were got all over the loch, but chiefly between Tarbert and Skipness. In July the fishing was almost entirely in the lower loch, chiefly at the mouth, and it thus continued in August, September, October, and November, most being taken in the vicinity of Skipness. The fishing fell off in November, and no herrings were caught in December.

In 1878 the aggregate catch fell to 8890 crans. In June the fishing was mostly about the entrance to the upper loch, and a good "appearance" was reported in the lower loch. In July, when most herrings were taken, the fishing was all over the lower loch, and as far up as Minard, and the "appearance" continued good. In August the weather was very fine, but the fishing fell off, and scarcely anything was taken in September and October. In the first week of November trials were made but no herrings taken; in the next week good takes were got at Skipness, where a large shoal was reported to be; in the third week the fishing was between Skipness and Tarbert, and later up to Ardrishaig and about Otter Spit, but it fell off, and very little was taken in December.

From this year until 1882 there was a gradual increase in the quantity of herrings landed.

In 1879 the aggregate was 21,045 crans. In June and July the fishing was all over the lower loch, and best between Skipness and Tarbert; at the end of June and in July herrings were also got near Inveraray and at the top of the loch. In the early part of August the fishing was over the upper and lower loch, but the best grounds continued to be about the mouth of the loch between Tarbert and Skipness, where large shoals were seen. Until the early part of November the fishing continued about the mouth and especially near Skipness; later it fell off, and a few crans of very small herrings were got in the upper loch. None were caught in December.

In 1880 the aggregate was 22,768 crans. In June the grounds were between Skipness and Tarbert and about the entrance to the upper loch, and till the early part of August most of the herrings were got at the former locality, and then also at Ardlamont and between Ardlamont and Tarbert. During the rest of the season the fishing was towards the mouth of the loch, particularly between Tarbert and Skipness, and about Skipness, and the drift-nets were more successful than the seines, which was not the case, the Officer remarks, in the previous few years. In November herrings were caught in considerable quantities between Ardlamont and Skipness, and also between Inverneil and Tarbert; later at various parts of the lower loch, especially towards Ardrishaig and

Tarbert, and in December near the mouth of the loch between Skate Island and Skipness. It is remarked that during the whole season the drift-net was more successful than the seine.

In 1881 the aggregate rose to 32,943 crans. In June the fishing was successful, and the herrings large and superior; they were nearly all taken by seines. In the early part of the month they were got between Skipness and Tarbert and near Otter; later also all over the upper loch as far as Inveraray. In July the particulars are scanty, but the fishing went on in both the upper and the lower loch. In August, when 9546 crans were landed, the fishing was almost only about Tarbert, little being caught in the upper loch. Till the end of October the fishing was chiefly between Tarbert and Skipness; then a shoal appeared between Ardlamont and Kilfinan; but in November and December the herrings were mostly secured between Inverneil and Skipness.

In 1882 the catch was the very high one of 55,754 crans. At the beginning of June some herrings were taken near Skipness and Otter Spit; most of those landed were caught between Skipness and Tarbert, and at the end of the month some were taken a few miles up the upper loch, and the fishermen reported that the herrings were gradually finding their way up the loch, and they expected a good fishing. In July 7860 crans were landed. Information is not given as to the place of fishing, but it appears to have been chiefly in the lower loch; in the first week it was principally about Laggan. In August it is stated that the fishing is all over the lower loch, and that the seine has been the more successful all season, and that nothing is doing above Otter. In this month 11,878 crans were landed. In September, when 8320 crans were taken, the only information is for the week ended 23rd, the principal grounds then being from Ardlamont to Otter; on the 9th it was remarked that there were still "immense shoals" in the lower loch. In October 12,663 crans were landed. In the week ended 14th it is stated that the grounds were quite close to Ardrishaig, and that no herrings were being got in the upper loch; later, that the grounds were from Ardrishaig to Tarbert. In the week ended 28th, 5240 crans were landed, 3000 crans on one day, and both drift-nets and seines did well. In November the grounds were still between Tarbert and Ardrishaig chiefly, and 11,424 crans were caught. The fishing fell off at the beginning of December, the shoals having left the loch. The fishing in this most productive year was thus almost exclusively in the lower loch.

In 1883 the total dropped to 36,109 crans. In June the grounds were chiefly between Tarbert and Ardrishaig, and 3304 crans were landed. In July, when 8465 crans were taken, the grounds were between Ardrishaig and Skipness, but a good fishing was also obtained in the upper loch. In August the localities are not mentioned, but the grounds appear to have extended from Otter Spit to Skipness and Ardlamont; one seine-net crew got a haul of 218 crans of "splendid" herrings, which realised no less than £557. In September nothing is said about the place of fishing; a single seine-net haul was sufficient to load five or six boats, and realised £575. On 6th October the Officer remarks that "It is almost incredible the large amount of money the Loch Fyne fishermen have earned since the middle of June. They never experienced such a remunerative season as this," and he mentions that the price ranged in that week from £2 15s. to £3 10s. per cran. In this month most of the herrings were got between Tarbert and Skipness, and also near Ardrishaig. In November there is no information as to the place of fishing; towards the end of the month the fishing fell off, and only 12 crans were landed in December.

In 1884 the catch fell below the average, viz., to 15,756 crans. In June there was a "splendid appearance" of herrings all over the lower loch, and the large quantity of 5154 crans were landed, but the localities of capture are not mentioned. In July, it is only stated that some good takes were got about Lochgair and Minard, but the bulk of the 3275 crans landed were doubtless got in the lower loch; the quality was very inferior, the herrings being small—the smallest and poorest for a number of years. The place of fishing in August is again omitted, but most herrings appear to have been landed at Tarbert; at the end of the month mackerel were more abundant than herrings. In September most of the fishing seems to have been in the neighbourhood of Tarbert and near Skipness; mackerel and saith, or coalfish, continued to be abundant. In October little was caught, and it was at the mouth of the loch, and most of the boats were fishing in Kilbrennan Sound. In November there was no "appearance" of herrings in Loch Fyne, and the trials made were unsuccessful, so that no herrings were landed in this month, or in December.

In 1885 the total catch was above the average, reaching 28,847 crans, most being taken in June and July. In June the catch was a record one for that month, viz., 7187 crans, and nearly all were secured in the lower loch, on the eastern side, during the first part of the month, and then between Ardrishaig and Tarbert. Several good takes were got above Otter Spit. In July 7244 crans were landed; at the beginning of the month there was a good "appearance" all over the lower loch and as far up as Minard, but the localities where the herrings were taken are not mentioned. In August most of the catch was landed at Tarbert, and the grounds were probably near the mouth of the loch; the same remark applies to September, and it appears that several of the crews were working in Kilbrennan Sound. In October the week ended 10th was the best of the season, 3050 crans being taken, and the place of fishing was at the entrance to the loch and about Skipness. Only three crans were taken after 17th October, the shoals having left, and the fishing came to an end.

In 1886 the catch fell to 15,062 crans. On 5th June the Officer states—"Owing to the fair success of the fishing during the month of May (the catch to date being 2334 crans), and the splendid appearance of herrings in the loch, fishermen made an early start." Much of the fish recorded for June appear thus to have been caught in May. In June the fishing was near Ardrishaig, and from Tarbert to Otter Ferry, and also as far up as Inveraray. In July the best fishing was in the upper loch near Inveraray. In August the fishing seems to have been both in the upper and lower lochs; mackerel were abundant, and some of the seine-net herrings were so small as to be unmarketable. In September the fishing was less productive, and was apparently mostly about Tarbert. At the latter part of this month the fishing fell off; there was little appearance of herrings, and what was taken was got at the mouth of the loch, about Skipness and the upper part of Kilbrennan Sound, and the fish were small and inferior, and this continued all the rest of the season.

In 1887 the aggregate was 14,360 crans. In May 1032 crans were secured, most being taken about Tarbert and on the opposite shore, at the entrance to the upper loch, and a few in the upper loch. In June they were taken chiefly near Ardrishaig, about Otter Spit, and some above Inveraray; at the end of the month the Officer notes that as yet few herrings had been taken below Tarbert. In July the herrings were caught mostly in the vicinity of Tarbert, near Skipness, at Otter Spit,

and in the upper loch. In August the catch fell off; in the first week they were taken in the neighbourhood of Tarbert, but there is no information as to the place of fishing from then till 17th September, when it is recorded that the fishing was very light in the upper loch, and that most of the boats were fishing in Kilbrennan Sound. In the early part of October none were taken in Loch Fyne; later, some were got near Tarbert and Ardlamont. In November only 198 crans were secured, mostly opposite Tarbert, and the fishing ended at the beginning of December.

From 1887 to 1891 the quantity taken gradually increased each year.

In 1888 the total amounted to 20,258 crans. In June, when 1111 crans were landed, the fishing was chiefly in the upper loch, by drift-nets. In July the quantity was 7147 crans, and the herrings were taken all over the loch, but mostly in the vicinity of Tarbert. In August 8640 crans were landed; there is no information as to locality for the first two weeks, but for the remainder of the month the fish were secured in the lower loch. In September the quantity fell to 1919 crans, mostly caught about Tarbert and Skipness. In October the quantity was 1092 crans, taken at the mouth of the loch, especially near Ardlamont. In November only 349 crans were obtained, all caught at the mouth of the loch, near Skipness, and none were taken in December.

In 1889 the aggregate was 29,865½ crans, of which 1830 crans were obtained in June, but the only information as to locality is that few were caught in the upper loch. In July 6364 crans were taken, mostly between Ardrishaig and Skipness, few being got in the upper loch. In August the catch was 5267 crans, mostly on the same grounds, and towards the end of the month off Skipness and Ardlamont Point. In September 3843½ crans were secured, chiefly off Laggan, about three or four miles south of Tarbert, and there was no "appearance" in the upper loch. A large quantity was landed in October, viz., 10,125 crans; in the first week most were caught between Tarbert and Skipness, but in the remainder of the month the best fishing was on the east side of the lower loch, south of Ardrishaig, and opposite Tarbert. In November the catch fell to 2436 crans, mostly got between Kilfinan and Ardlamont on the east side. In this year apparently few herrings were taken in Upper Loch Fyne.

In 1890 the aggregate catch amounted to 38,291½ crans. The quantity landed in June was 1936 crans; they were at first taken in small numbers all over the loch from Skipness to above Inveraray, then chiefly about Skipness and Tarbert, and later, near Ardrishaig. On the 21st, it is noted that a large shoal of herrings had entered the loch and were moving up along the west side towards Ardrishaig. In July the large quantity of 12,303 crans were landed, which is the largest for that month in the records. The great bulk of the catch was got on the east side of the lower loch, opposite Tarbert, and near Skate Island, but herrings were caught more or less all over the lower loch, while few were obtained in the upper loch. In August 8254 crans were taken, mostly opposite Tarbert, about Yellow Island and Buck Island. In September the catch fell to 3809½ crans, most of the herrings being caught about Yellow Island, and towards the end of the month on the west shore, near Laggan. In October the catch was 3285 crans, taken partly on the east side near Yellow Island, and between Skate Island and Ardlamont, and partly near Laggan and near Skipness. In November the catch was still higher, viz., 3463 crans, near Ardrishaig, between Ardrishaig and Tarbert, and also in the upper loch, especially in the vicinity of Minard. In December 5241 crans were landed, mostly taken about Otter Spit and the entrance

to the upper loch, in the upper loch, and towards the end of the month also along the east side of the lower loch.

In 1891 the aggregate was 48,228 crans. In June it is recorded that several dense shoals entered the loch in May, and the best fishing was in the upper loch, though takes were got all over the loch. In July, when 10,283 crans were landed, most were got between Tarbert and Ardrishaig, between Tarbert and Skipness, about Skipness, and near Ardlamont. In August the catch fell to 3783½ crans, and in September to 3639½ crans, the herrings being taken on the same grounds as in July. In October 9388 crans were landed, most of them being taken off Castleton, along the east shore of the loch, near Ardrishaig, and above Otter Spit. The dense shoals which had entered the loch in June had retired to deep water, and were now breaking up preparatory to leaving the loch. In November the very large quantity of 11,038 crans was secured, 5001 in the first week in Kilfinan Bay and between Strachur and Otter Spit, and during the remainder of the month, and particularly in the last week, off Inveraray and at Minard; the bulk were thus taken in the upper loch. In December the unprecedented catch for that month of 7937 crans was taken, at first in the upper loch and best near Minard, then in the lower loch on the east side, particularly about Kilfinan Bay; in the week ended 31st December, 4493 crans were landed, chiefly from the upper loch, near Minard.

From 1891 to 1895 the annual yield was gradually reduced to a point considerably below the average.

In 1892 the aggregate was not much lower, viz., 47,408½ crans. In June, when 4509 crans were taken, the herrings were caught all over the loch, but chiefly between Skipness and Tarbert, and near Inveraray. In July 9206 crans were landed, taken all over the upper and lower loch, but mostly between Skipness and Tarbert, also near Ardrishaig. In August the catch amounted to 11,129 crans, caught mostly between Skipness and Laggan, but all over the loch as far as Inveraray. In September the total was 8406½ crans, by far the greater part being got between Skate Island and Ardlamont, and between Tarbert and Skipness. In October the catch totalled 3641 crans, nearly all from the upper loch, and particularly between Furnace and Inveraray. Several dense shoals were reported to be in the upper loch, but keeping in the deep water in the central channel. In November the total was 3377 crans, practically all from the upper loch, and mostly between Minard and Strachur. In December 7140 crans were landed, by far the greater part being caught in the upper loch, between Minard and Otter Spit.

In 1893 the aggregate catch amounted to 36,389½ crans. In June 3251 crans were landed, the fishing being all over the loch, but best near Tarbert and in the vicinity of Minard. In July 10,802½ crans were taken, also all over the loch, but best at Ardlamont and on the opposite side near Laggan. The quantity got in August was 10,075½ crans, and the herrings were caught both in the upper and the lower loch, in the latter chiefly about Skate Island. In September the catch fell to 2700½ crans, caught near Skate Island, between Tarbert and Ardrishaig, and in the upper loch. The total in October was only 705 crans; herrings were reported to be plentiful in the upper loch between Minard and Inveraray, but they stayed in the deep water, what were taken being caught by drift-nets down to 30 and 40 fathoms from the surface. At the beginning of November the shoal began to move from the deep water, and most of the 4416 crans secured were got between Minard and Otter, and from Minard to Inveraray, chiefly by seines. In December 4439 crans were taken, mostly about Minard and Loch Gair.



In 1894 the aggregate catch was slightly greater, viz., 38,367 crans. In June, most of the 3049 crans got were apparently taken in the lower loch, as at Skipness. In July 10,827 crans were landed, and they were nearly all taken in the upper loch, especially from Minard to Inveraray. In August the catch totalled 9320 crans, also got in the upper loch, between Craras and Inveraray. In September 3024 crans were secured, almost all in the upper loch, from Minard to Inveraray, and especially in the upper reaches about and above Inveraray. The catch in October again fell, the quantity taken being 1041 crans, and they were got in the upper loch in the vicinity of Inveraray and Strachur by drift-nets, sunk as far from the surface as 40 to 60 fathoms, but the fishermen stated that the shoal was at the bottom in deeper water. In November the catch was 3100 crans, apparently all from the upper loch; during the first three weeks they were caught by drift nets, but at the end of the month heavy catches were secured by seines at the head of the loch, near Cairndow. In December the catch was the high one of 7451 crans, and they were taken in the lower parts of the upper loch, from Minard and Furnace to Otter Spit, and Ardrishaig and Inverneil in the lower loch. At the end of the year herrings were said to be still abundant in the upper loch.

In 1895 the total amounted to 17,853 crans, of which 1090 crans were caught between 1st January and 1st June, but the locality and time are not specified. In June 2117 crans were taken all over the loch, but mostly about Tarbert and in the upper loch. In July the catch was 4271 crans, most being got in the upper loch. The total in August was somewhat greater, 5508 crans, mostly got in the upper loch, especially between Strachur and Cairndow, but also near Tarbert, and between Tarbert and Skipness. In September the aggregate fell to 1674 crans, mostly taken in the upper reaches of the upper loch. Only 155 crans were obtained in October, apparently chiefly about Skipness. In November 1800 crans were taken, chiefly in the upper loch, but also between Tarbert and Ardrishaig. The catch in December was rather less, 1238 crans, and mostly secured between Tarbert and Ardrishaig, as at Inverneil. In this year, therefore, the bulk of the herrings were caught in the upper loch.

The aggregate catch in 1896 was 18,406 crans, of which 2012 crans were caught between 1st January and 1st June, without specification of locality being given. In June the herrings appear to have been mostly caught in the upper loch. In July, and, indeed, throughout the whole year, by far the larger quantity was taken in the upper loch, and in the upper reaches of it; but in August and in October it is stated that catches were got near Tarbert, and between Tarbert and Skipness. No information is given for the first two weeks in December, in which month only 324 crans were secured; in the third week it is stated that the fishing in the upper loch was blank, and that the herrings taken in that week were got between Tarbert and Skipness. In the last week of the year there was no "appearance" of herrings in the loch. The bulk of the catch in this year was again from the upper loch; and it is noted in the closing months of the year that the herrings taken by seine were very small and inferior, the fishermen often allowing them to escape as being too small for market.

The year 1897 was the most productive in the period from 1863 (or 1854) to 1906, and it is interesting from the fact that it is the only instance where a very good year follows a year below the average. The aggregate amounted to 56,820 crans, thus apportioned:—

To 1st June.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
849	1,756	5,876	10,797	19,900	6,316	5,763	5,563

The localities and months in which the herrings taken before June were caught are not mentioned. In June, when the total was a comparatively small one, the herrings were got in both the lower and the upper loch. In July there is no information in three of the weeks as to the place of fishing; in the other weeks it was "all over loch." In August, again, when the fishing was very successful, no place is specified, but in the week ended 21st it is said that there are large shoals all over the loch. The total for September was the enormous one of 19,900 crans, the largest for any month in the period from 1854. In the two first weeks, when 9930 crans were landed, the fishing was "all over the loch"; in the next week, when the catch was 4046 crans, it is stated that the best fishing was from Minard to Silver Craigs, in the upper loch, and along the Kilfinan shore in the lower loch; in the next week no information is given and in the last week the fishing was all over the loch. In October 6316 crans were secured, but there is information as to the places of capture only for the last two weeks, when most were caught off Loch Gair, Silver Craigs, and on Kilfinan shore. In November the catch amounted to 5763 crans, the localities when mentioned being off Loch Gair and all over the loch. Particulars are given in December for only the first week, when 2045 crans were taken, mostly in the upper loch, from Otter Ferry to opposite Newton.

The aggregate in 1898 amounted to 40,801 crans, of which 736 crans were secured before 1st June. In June 4252 crans were caught between Skipness and Furnace.

In 1899 the total was 32,113 crans. In June the fishing was all over the loch, principally from Skipness to Minard. In July, when 8552 crans were taken, it was also generally distributed from Otter Spit to Cairndow and down to Tarbert. In August it appears to have been chiefly in the upper loch, as was also the case in September, but the information is meagre. No information is given as to the place of fishing from the week ended 7th October, when it was in the upper loch mostly, until the week ended 18th November, when it was in the upper and lower lochs, especially about Loch Gair. In December the herrings were caught mainly in the upper reaches and opposite Tarbert.

In 1900 the catch fell to 24,743 crans. In June the herrings were caught between Skipness and Otter, and especially about Otter. In July, when 7523 crans were secured, the only information is for the week ended 21st, when the fishing was best about Minard. The information for the remainder of the year is scanty; in August and the first part of September the fishing seems to have been chiefly in the upper loch and about Tarbert. After this the only localities mentioned are Laggan and Skipness, Skate Island and Ardlamont, and between Ardrishaig and Tarbert; in most of the weeks no particulars are given.

In 1901 there was a slight increase in the aggregate, to 29,117 crans. The information as to the localities of fishing in this year is very inadequate; of the thirty-two weeks included no particulars are given for twenty-two of them. In June, herrings were taken near Otter and from Otter to Laggan; in July, some were taken near Inveraray; in August, Skipness to Tarbert is mentioned; in September the fishing was probably mostly in the upper loch; in November, Otter, Skipness, and Inveraray are mentioned, and in December, Otter.

In 1902 the aggregate was 26,339 crans. In June and July the places mentioned are Laggan and Otter; in August, Laggan and Tarbert to Skipness, and also the upper loch; in September and October the fishing appears to have been mostly in the same quarters; in November and December the upper loch, near Ardlamont, Kilfinan Bay, and latterly near

Otter are the places mentioned. In these months most of the boats were, however, fishing in the Kyles of Bute.

In 1903 the catch was 21,198 crans. In June the herrings were taken at first near Skipness and Laggan, then from Tarbert to Otter and at Otter. In July, Otter and Laggan are mentioned, and also the upper loch; in August the fishing was apparently in the upper loch, but in September the chief grounds were about Ardlamont, and up from there along the east side of the lower loch. The Officer notes on 5th September that the fishermen thought the herrings were about to enter the Kyles of Bute, as they did in the previous year. In October there was little "appearance" in Loch Fyne, the fishing chiefly going on in the Kyles. In November only 111 crans were landed, the boats fishing mostly in the Kyles, and thus in Rothesay district. In December the quantity taken was 642 crans, some of which at least were caught near Skate Island.

In 1904 the catch fell to 7827 crans. In May it is noted that the herrings had not yet made their appearance in Loch Fyne, and the boats were fishing for the most part in Kilbrennan Sound. In June the places mentioned are near Otter, south of Tarbert, and the upper loch, and the herrings were apparently chiefly taken in the upper loch. In July the fishing was mostly in the upper loch and south of Tarbert. In August it appears to have been in the upper loch and near Ardlamont; it was the same in September, and at the end of the month the boats were fishing chiefly in the Kyles of Bute, and about Inchmarnock. In October only 13 crans were landed, and they were taken in the upper loch. No herrings were taken in November, and in December the few caught were secured mostly at Minard, between Minard and Furnace, and near Ardlamont.

In 1905 the catch was the lowest since 1873, aggregating only 4672 crans, less than is sometimes taken in a single week. They were apportioned as follow:—

To 28th April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
558	970	512	440	327	210	328	419	908.

May and December were thus the best months. In May the herrings were taken at Otter Spit, near Ardlamont and Skipness, and also in the upper loch, near Minard. In June some were taken in the vicinity of Skipness, between Skipness and Tarbert, at Otter and near Minard. In July they were chiefly caught about Skipness and in the upper loch. Those taken in August were secured mostly in the upper loch, about Crarae and off Newton, and some about Skipness. In September the herrings were taken almost entirely in the upper loch, principally near Strachur. In October small catches were got at Ardlamont, Skate Island, Kilfinan, and Skipness in the lower loch, and at Strachur and near Inveraray in the upper loch. It was reported that there were many herrings in the upper loch, but that they were keeping in deep water, and the fish were of a very large size. In November a few herrings were got about Skipness and Laggan and also in the upper loch. In December 908 crans were taken, mostly about Minard and Loch Gair, in the upper loch.

In 1906 the catch was but little greater, the total being 5258 crans, of which 234 crans were taken before 28th April. The quantities in each month were as follows:—

To 28th April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
234	522	706	1,022	286	699	1,484	255	50

In May the herrings were caught about Laggan, Kilfinan, and Loch Gair. In June and July most of the fish were secured between Skipness and Tarbert, especially between Laggan and Skipness, also at Ardlamont, and in the upper loch at the end of July. Mackerel were said to be plentiful in the loch in the latter part of July. In August herrings were very scarce in the lower loch, but some were caught near Newton in the upper loch. On the 18th, it was reported that the shoals which had been on the east side of Arran were moving up towards Loch Fyne, but in the next week it is noted that they had turned back. In September the fishing was mostly in other districts, especially at Garroch Head and off the east of Arran. In October, which was the best month of the year, the herrings were secured between Skate Island and Ardlamont, about Inchmarnock, and between Arran and Bute. In November and December the weather was mostly unsettled, and few herrings were caught. On 8th December the Officer notes that the shoal which had been lying in the upper reaches of the loch had left unobserved, the general opinion of the fishermen being that the herrings had gone south to the spawning banks.

*Campbeltown and Inveraray Districts Combined.*

It has already been explained that these districts were combined from the year 1854, when the records begin, until 1863, and I have accordingly combined in the Tables (IX.-XXIII., pp. 114, 179), the totals for the two districts since 1863 in order to allow a comparison to be made as to the fluctuations for the last 53 years. The two districts are contiguous, and the boats of the one often fish within the limits of the other. The statistics relate essentially to the area of water which extends from the south end of Kilbrennan Sound up to the top of Loch Fyne, and represent the yield in this long stretch of narrow waters. In the 53 years the total quantity of herrings taken in it amounted to about 2,304,950 crans, or 8,067,300 cwts., the annual average for the whole period being 43,490 crans. If this period be divided into two parts of 26 years each, viz., 1854-1879, and 1881-1906, and a comparison made between them, it will be seen that the second half was all but twice as productive as the first. In the years 1854-1879 the quantity was 775,058 crans, the annual average being 29,810 crans, while in the years 1881-1906 the quantity was 1,469,604 crans, with an annual average catch of 56,523 crans. The annual average excess in the second period over the average in the first was no less than 26,713 crans, which shows how the herring fishery in this region of the Clyde has been developed. This development has been much more in the southern part of the area, in the district of Campbeltown, than in Loch Fyne.

When the figures are arranged in ten-year periods, the annual averages for each period are as follows:—

1857-66 ..	29,557	1887-96 ..	57,101
1867-76 ..	28,440	1897-1906 ..	51,392
1877-86 ..	54,966		

Arranged in five-year periods, the averages, in both cases in crans, are these:—

1857-61 ..	27,712	1882-86 ..	66,267
1862-66 ..	31,402	1887-91 ..	65,053
1867-71 ..	34,689	1892-96 ..	49,149
1872-76 ..	22,191	1897-1901 ..	67,083
1877-81 ..	43,665	1902-06 ..	35,701

A comparison of the tables referred to and of the curves (Pl. IV.) shows that in certain cases the fluctuations in the two districts are complementary, a rise in one being associated with a fall in the other, and in other instances they fluctuate together, both rising or both falling in the same year.

Thus in the period when the productiveness of the fishing in Loch Fyne was least, in 1872-1874, there was a rise in the yield in the Campbeltown district, and it fell again as the Loch Fyne fishing improved, conditions which might be explained on the assumption that shoals which usually entered Loch Fyne from Kilbrennan Sound remained in the Sound in those years. The figures for the years 1871 to 1875 are as follows:—

		Campbeltown.	Loch Fyne.	Total.
1871	..	5,063	13,515	18,578
1872	..	15,432	9,057	24,489
1873	..	15,891	3,648	19,539
1874	..	15,400	4,806	20,206
1875	..	3,065	13,546	16,611

The same sort of relationship is shown in the years 1884-1890, the number of crans taken in the two districts in each of those years being as follows:—

		Campbeltown.	Loch Fyne.	Total.
1884	..	33,572	15,756	49,328
1885	..	36,842	28,847	65,689
1886	..	29,318	15,062	44,380
1887	..	43,535	14,360	57,895
1888	..	41,369	20,258	61,627
1889	..	32,906	29,865	62,771
1890	..	25,453	38,291	63,744

But in the years 1895 and 1896, when the yield in Loch Fyne was low, the yield in the Campbeltown district was also low, viz:—

		Campbeltown.	Loch Fyne.	Total.
1895	..	15,765	17,853	33,618
1896	..	14,973	18,406	33,379

In the first portion of the period of recent depression in Loch Fyne (from about 1900 to last year), the catch in the Campbeltown district was above the average, but in the last three years it fell below it, as the following figures show:—

		Campbeltown.	Loch Fyne.	Total.
1899	.	31,898	32,113	64,011
1900	..	40,557	24,743	65,300
1901	..	31,349	29,117	60,466
1902	..	38,016	26,339	64,355
1903	..	29,762	21,198	50,960
1904	..	12,906	7,827	20,733
1905	..	21,458	4,672	26,130
1906	..	11,070	5,258	16,328

A possible explanation is that the shoals that usually visit the area did not in the first part of the period of depression penetrate in large numbers

beyond Kilbrennan Sound, and then withdrew from it more and more ; so that while the aggregate catch for the whole area remained much about the same at first, it latterly fell off.

If we take the period of years from 1887 to 1899, during which the catch in Loch Fyne was high above the average except for the two years 1895, 1896, we shall find the curve for the Campbeltown district, *when smoothed*, forms a depression of regular form. The figures are as follows :—

	Campbel- town.	Loch Fyne.		Campbel- town.	Loch Fyne.
1887 ..	43,535	14,360	1894 ..	18,062	30,870
1888 ..	39,270	21,495	1895 ..	18,339	24,875
1889 ..	33,243	29,472	1896 ..	18,313	31,026
1890 ..	29,786	38,795	1897 ..	20,997	38,676
1891 ..	24,872	44,643	1898 ..	26,639	43,245
1892 ..	21,091	44,009	1899 ..	32,091	32,552
1893 ..	18,861	40,722	1900 ..	31,349	24,743

In one or two years, and notably in 1882, quantities much above the average were taken in both districts; in that year the highest recorded for the Campbeltown district was landed (43,609 crans), and the second highest for Loch Fyne (55,754 crans), the aggregate for the two districts being 99,363 crans.

#### THE CLYDE AREA.

According to the weekly returns, the aggregate quantity of herrings taken in the five districts which comprise the whole of the Clyde area since 1854 has amounted to 3,314,585 crans, or about 11,601,000 cwts., the annual average for the period being 62,540 crans. Comparison between the first twenty-six years and the last twenty-six years shows that the herring fishery has been much more productive in the latter period.

Years.	Crans Landed.	Average per annum.
1854-1879 ..	1,254,902	48,270
1881-1906 ..	1,950,849	75,030
Excess ..	695,947	26,760

If the statistics are arranged in ten-year periods, the annual averages come out as follows :—

1857-66 ..	46,225½	1887-96 ..	74,523½
1867-76 ..	51,454½	1897-1906 ..	67,518
1877-86 ..	81,523½		

And the averages for periods of five years are :—

1857-61 ..	32,955	1882-86 ..	89,732
1862-66 ..	59,496	1887-91 ..	93,212
1867-71 ..	68,417	1892-96 ..	55,835
1872-76 ..	34,492	1897-1901 ..	74,495
1877-81 ..	73,315	1902-06 ..	60,541

The maximum quantity landed in any one year was in 1882, when the aggregate amounted to 119,130 crans ; and the total was over 100,000

crans on other five occasions, viz., in 1880, 1883, 1890, 1891, and 1902. The minimum quantity was 17,080 crans in 1854; in 1861 the quantity was 20,307 crans, and in 1904 it was 29,992 crans.

The curve formed from the annual figures (Pl. IV.) shows that, in the first twenty-six years, the only years in which the quantity of herrings landed was above the mean for the whole period were 1862, and 1865 to 1870; in the second twenty-six years, the only years below the mean for the whole period were 1886, 1893, 1895, 1896, and 1904-1906. The periods of greatest scarcity were from 1871 to 1878, and especially 1873-1875; 1893 to 1901, and 1904 to 1906. The mean annual quantities in those years were as follows:—

	Crans.		Crans.
1871-78 ..	37,510	1895-96 ..	39,380
1873-75 ..	30,458	1904-06 ..	40,132
1893-1901..	64,079		

It is not intended at present to enter in any detail into the fluctuations of the catch of herrings from year to year in the various districts of the Clyde, but attention may be drawn to one or two features of interest.

One of these relates to the penetration of the upper reaches of the Clyde by shoals of herrings, as described in the foregoing accounts of the districts. Thus, if the tables and curves for the Rothesay and Greenock districts be examined, and the foregoing account referred to, it will be evident that large shoals of herrings penetrated to the upper parts of the Clyde in the years 1864-1872. In 1862 a few herrings were taken in the Kyles of Bute and Loch Riddon in November and December, but the total only amounted to 109 crans. In the autumn of the following year, and especially in December, much larger quantities were caught in the lower parts of the Kyles and in Loch Riddon; in 1864 the shoals appeared in greater numbers, fishing in the Kyles beginning at the latter part of September and continuing to the end of December, the herrings in this year penetrating to Loch Striven and Port Bannatyne, but none apparently reaching the northern lochs (Loch Long, Loch Goil), and the fishing ending in December. In 1865 the same thing is repeated, shoals setting into the Kyles about the middle of September, penetrating to Loch Striven and Port Bannatyne, and a successful fishing going on to the end of January. In 1866 a similar movement occurs, but in this year the herrings penetrate at the end of November and the beginning of December to Loch Long. In 1867 the fishing was in the Kyles and the northern lochs. Up to this year it appears to be probable that the herrings made their way to the north by the Kyles of Bute, extending farther and farther up the Clyde. But in 1868 the herrings coming from the south seem to have come by another route to the east side of Bute, and the grounds this year were in the Greenock district, opposite that town, and also in Lochs Long and Goil. In 1869 both routes appear to have been followed, abundance of herrings being taken in the Kyles, in the northern lochs, and off Greenock. In 1870 the fishing was much less successful, and was chiefly in Loch Striven, the northern lochs, and in the channel of the Clyde, and in this year the herrings appear to have come by the eastern route. In 1871 comparatively little was taken in the Kyles, the herrings being chiefly in the northern lochs and the channel of the Clyde, and the total catch was much diminished. In 1872 the catch was still less and chiefly in the northern lochs, while in the following year the shoals did not visit either the Kyles or the lochs, and did not come

back for many years. The quantities of herrings taken in October, November, December, and January in each season were as follows, in crans :—

Rothessay District .	1863-64 3,655	1864-65 33,428	1865-66 37,896	1866-67 37,257	1867-68 18,346
Greenock District .	—	—	—	—	—
Rothessay District .	1868-69 7,984	1869-70 20,235	1870-71 15,400	1871-72 9,376	1872-73 7,585
Greenock District .	32,685	14,657	1,635	1,100	—

The records of the Rothessay district show that in the years 1887-1891 herrings were again got in considerable numbers in Lochs Long, Goil, Striven, and in the Kyles, but in these years they were taken in the early part of the season, and there was no productive winter fishing in the region till 1902. In that year, in the months of November and December and in January 1903, between 28,000 and 29,000 crans were caught in the Kyles of Bute and Loch Riddon. In 1903 the shoal again entered the Kyles about the middle of October, and from then till the end of January about 19,000 crans were taken. At the end of September, 1904, the herrings again visited the Kyles and Loch Riddon, but disappeared from those waters about the middle of October; and in the following year there was practically no fishing in the Kyles, the chief fishing being between the Ayrshire coast and Arran. In August and September, 1906, the principal fishing ground was also close to the east side of Arran, from which the shoals moved northwards, and a considerable winter fishing was established opposite Greenock and in the Gareloch in the winter 1906-7. It is of interest to note that after an interval of about thirty-six years the shoals should again penetrate at the end of the year to the upper reaches of the Clyde.

One fact of considerable interest that is brought out is that the fluctuations in two successive years are rarely extreme; it is uncommon for a very good year to be followed by a very bad one, or for a very bad year to be followed by a very good one; the rule being for several years in succession to be bad or good. An examination of the curves of the annual yield of the various districts will make this clear. Thus, as above described, the shoals of herrings frequented the upper reaches of the Clyde in the winter months for a number of years from 1863 on, and gradually withdrew. The curve for the Ballantrae district also shows the abundant shoals that visited that part of the coast in the years 1878 to 1881, and again in 1883-1885, and the great scarcity in the years from 1892 to 1899.

The curve showing the annual fluctuations in Loch Fyne deserves special attention. It will be seen from it that as a general rule the good years and the bad years come in groups, and that only on one occasion, 1897, a very good year follows a year in which the yield was below the average. The years in which the yield was above and below the mean for the whole period from 1863 to 1906 may be arranged as follows, those below the line representing the years below the average, and those above it the years above the average :—

1865-70	1881-83	1885	1889-94	1897-99	1901-02
1863-64	1871-80	1884	1886-88	1895-96	1900
					1903-06



An examination of the curve (Pl. II.) shows, moreover, that the recent period of depression closely resembles that which began in 1871, the years 1872-1874 being very similar, both in regard to absolute quantities of the herrings caught and in relation to one another, to the years 1904-1906. It will also be seen that in the various periods there are never more than two very bad years in succession, viz., 1873-1874, 1886-1887, 1895-1896. Judging, therefore, from all these circumstances, it may with some probability be inferred that the catch in 1907 will be higher than in 1906, though likely still under the average.\*

In order to be able to compare the extent of the annual fluctuations in the yield of herrings in Loch Fyne with the fluctuations on other parts of the coast, I have had tables prepared showing for the period for which statistics are available, 1889-1906, the annual yield and the percentage above and below the mean catch for two East Coast districts, Anstruther and Peterhead, Loch Carron, and for the whole Clyde, the whole of the West Coast, and the whole of the East Coast.

TABLE showing the Total Quantity of Herrings Caught (in Crans) per year from 1889 to 1906, and the Percentage above or below the average catch for the period given.

	ANSTRUTHER.			PETERHEAD.			LOCH CARRON.		
	Mean, 27,739 Crans.			Mean, 144,003 Crans.			Mean, 28,057 Crans.		
Year.	Total Crans.	% above Mean.	% below Mean.	Total Crans.	% above Mean.	% below Mean.	Total Crans.	% above Mean.	% below Mean.
1889	20,069	...	27.7	167,705	16.5	...	36,882	31.5	...
1890	7,419	...	73.3	159,986	11.1	...	39,782	41.8	...
1	10,989	...	60.4	115,251	...	20.0	41,465	47.8	...
2	10,037	...	63.8	157,949	37.5	...	24,108	...	14.1
3	29,995	8.1	...	200,871	39.5	...	63,890	127.7	...
4	15,495	...	44.1	181,953	26.4	...	34,199	21.9	...
5	12,853	...	53.7	168,958	17.3	...	41,513	48.0	...
6	13,155	...	52.6	166,897	15.9	...	26,110	...	6.9
7	14,500	...	47.7	77,847	...	45.9	8,762	...	68.8
8	9,719	...	65.0	192,622	33.8	...	13,565	...	55.2
9	23,644	...	14.8	63,821	...	55.7	37,418	33.4	...
1900	47,590	71.6	...	63,276	...	56.1	60,816	116.8	...
1	47,369	70.8	...	68,124	...	52.7	31,319	11.6	...
2	57,554	107.5	...	147,215	2.2	...	8,307	...	70.4
3	38,694	39.5	...	133,890	...	7.0	18,927	...	32.5
4	44,625	60.9	...	172,645	19.9	...	14,254	...	49.2
5	45,531	64.1	...	161,945	12.5	...	2,480	...	91.2
6	50,059	80.4	...	191,092	32.7	...	1,225	...	95.6

\*The catch in Lochfyne during the present season (1907) is considerably above the catch in 1905 and 1906, as shown by the following figures (crans) for corresponding dates:—

1903. (17th Oct.) 20,415	1904. (22nd Oct.) 7633	1905. (21st Oct.) 3324	1906. (20th Oct.) 4953	1907. (19th Oct.) 13,348
--------------------------------	------------------------------	------------------------------	------------------------------	--------------------------------

[TABLE.]

TABLE showing the Total Quantity of Herrings Caught (in Crans) per year from 1889 to 1906, and the Percentage above or below the average catch for the period given.

	LOCH FYNE.			WHOLE CLYDE.			WEST COAST.			EAST COAST.		
	Mean, 29,094 Crans.			Mean, 69,512 Crans.			Mean, 222,314 Crans.			Mean, 698,007 Crans.		
Year.	Total Crans.	% above Mean.	% below Mean.	Total Crans.	% above Mean.	% below Mean.	Total Crans.	% above Mean.	% below Mean.	Total Crans.	% above Mean.	% below Mean.
1889	29,865½	2·7	...	87,357	25·7	...	193,711	...	12·9	814,550	16·7	...
1890	38,291½	31·6	...	102,733	47·8	...	283,093	27·3	...	758,258	8·6	...
1	48,228	65·8	...	106,774½	53·6	...	357,772	60·9	...	550,275	...	21·2
2	47,408½	62·9	...	74,940	7·8	...	249,042	12·0	...	748,684	7·3	...
3	36,389½	25·1	...	57,691	...	17·0	266,093	19·7	...	902,385	29·3	...
4	38,367	31·9	...	67,783½	...	2·5	189,483	...	14·8	807,935	15·7	...
5	17,853	...	38·6	40,332½	...	42·0	198,071	...	10·9	777,426	11·4	...
6	18,406	...	36·7	38,428	...	44·7	169,835	...	23·6	807,136	15·6	...
7	56,820	95·3	...	86,996	25·2	...	229,669	3·3	...	429,627	...	38·4
8	40,801	40·2	...	68,357	...	1·7	249,732	12·3	...	870,695	24·5	...
9	32,113	10·4	...	71,110½	2·3	...	215,823	...	2·9	434,957	...	37·7
1900	24,743	...	15·0	72,935	4·9	...	238,967	7·5	...	436,573	...	37·5
1	29,117	0·04	...	73,078½	5·1	...	202,983	...	8·7	550,376	...	21·1
2	26,339	...	9·5	100,397	44·4	...	232,553	4·6	...	783,024	15·0	...
3	21,198	...	27·1	81,905	17·8	...	203,625	...	8·4	680,476	...	2·5
4	7,827	...	73·1	29,992	...	56·9	185,794	...	16·4	781,886	12·0	...
5	4,672	...	83·9	36,802	...	47·1	177,046	...	20·4	660,929	...	5·3
6	5,258	...	81·9	53,601	...	22·9	158,356	...	38·8	768,929	10·2	...

The mean annual quantity for Loch Fyne, Anstruther, and Loch Carron district is very much the same, and it will be seen that the range of variation from the mean in different years, or the amount of annual fluctuation, is greater in the Loch Carron district than in Loch Fyne, while it is practically the same in the Anstruther district as it is in Loch Fyne. One may conclude, therefore, that the fluctuations in Loch Fyne are not abnormally great, and are such as might be expected under natural conditions.

It may be noted, further, in connection with the fluctuations in Loch Fyne that the bad years, in which the quantity of herrings caught is small, are, as a rule, characterised by a scarcity of herrings in the later months of the season. This is shown in the following table showing the percentage proportions taken per month over the whole period, and in the best and the worst years:—

	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1863–1906 ..	9·1	22·4	23·7	16·35	12·1	9·1	5·8
Five best years ..	6·1	17·2	18·1	20·1	15·4	12·8	8·8
Four worst years ..	16·2	25·2	9·1	13·3	14·8	3·8	5·2

In the whole period the mean proportion taken in the last three months is 27 per cent. of the whole; in the five best years it is 37 per cent., and in the four worst years it is 23·8 per cent.

#### THE INFLUENCE OF THE MOON ON THE CATCH OF HERRINGS.

It is a common opinion that the changes of the moon have an influence on the catches of herrings, and since the weekly reports offered

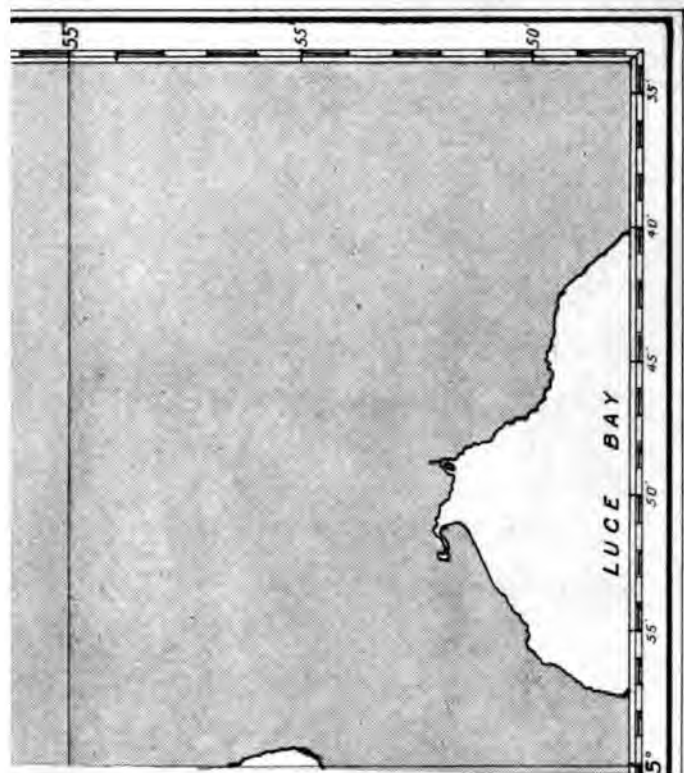
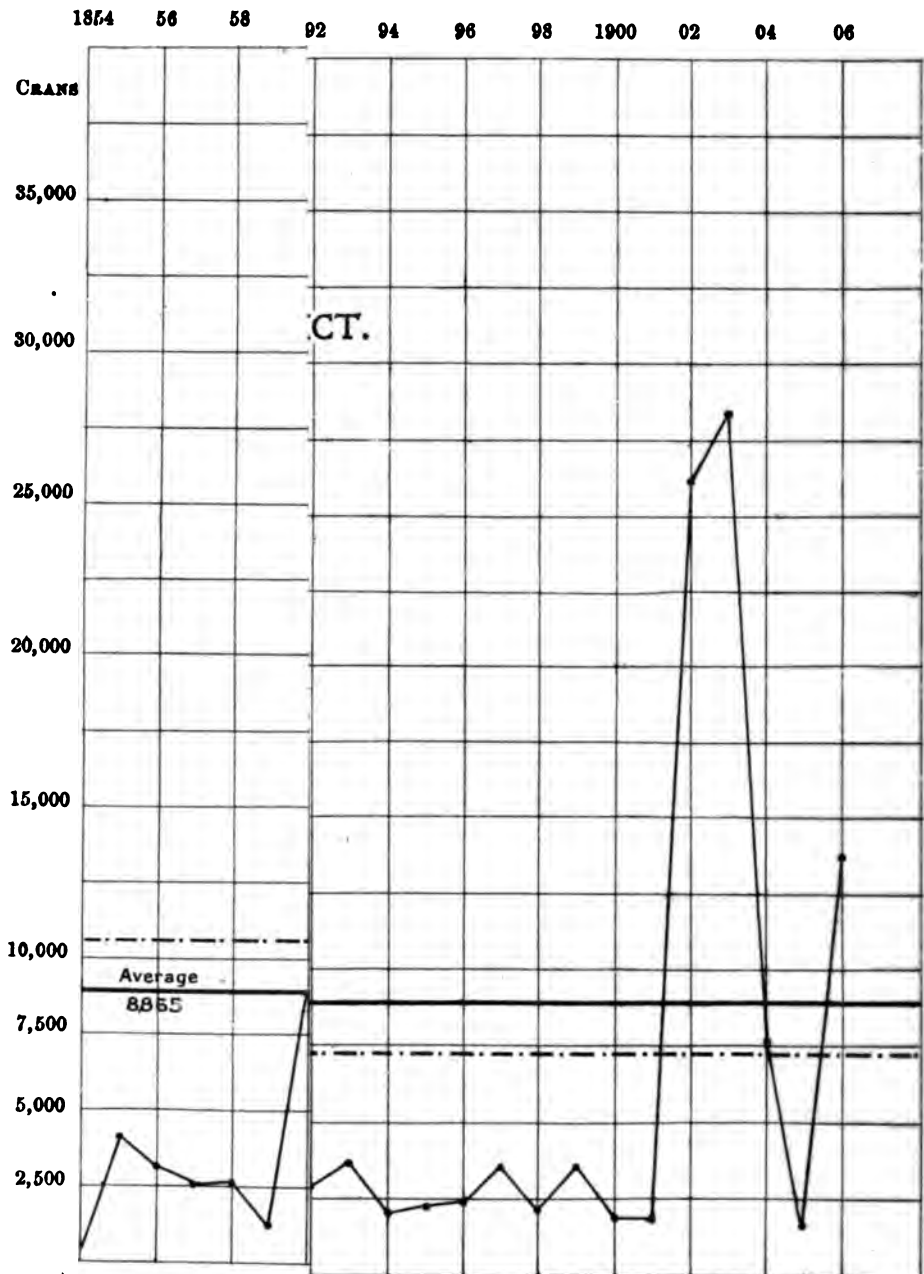




PLATE II.



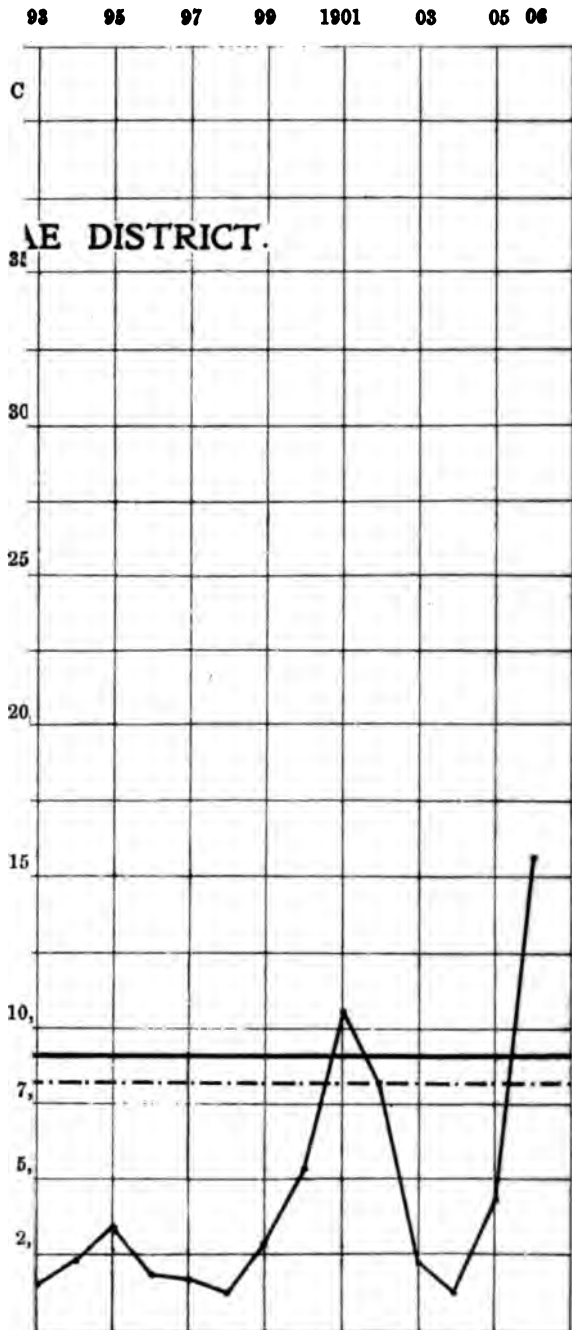
1. The first part of the document is a list of names and dates.

2. The second part of the document is a list of names and dates.

3. The third part of the document is a list of names and dates.

4. The fourth part of the document is a list of names and dates.

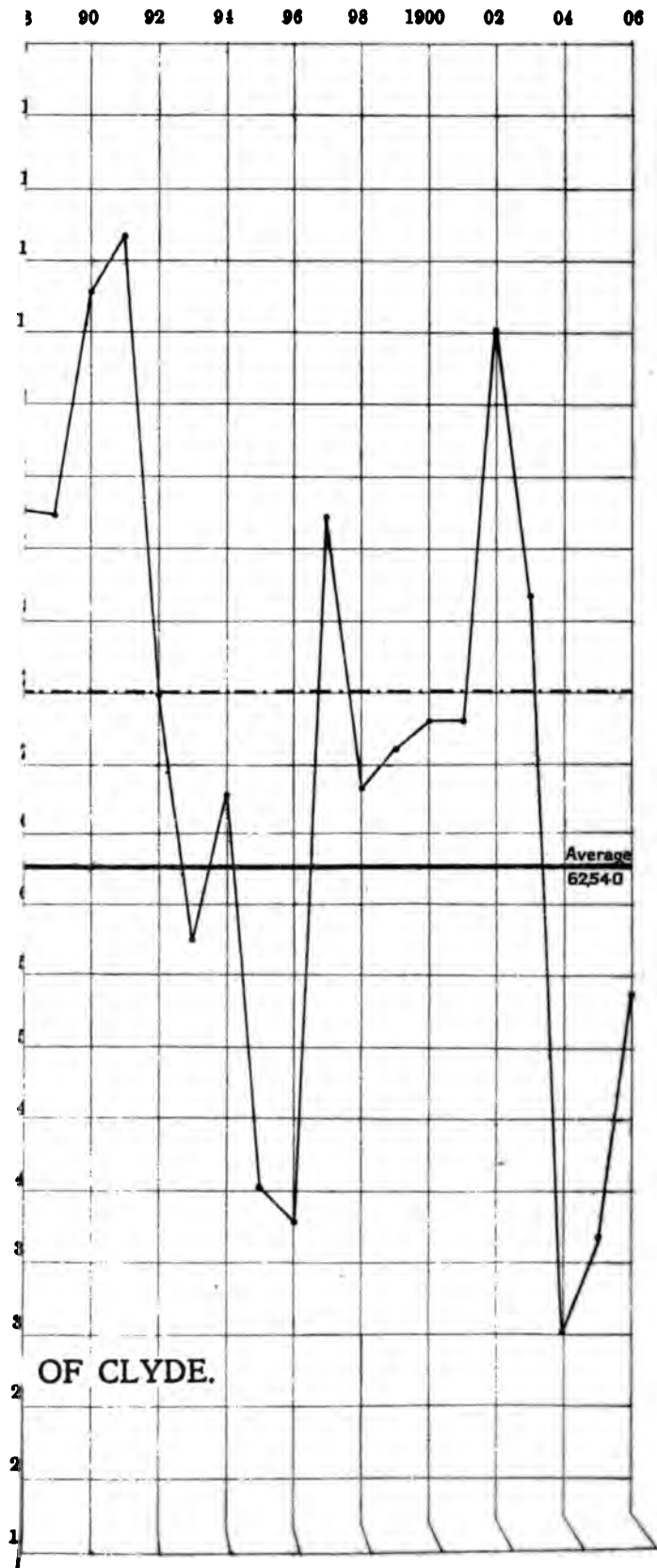
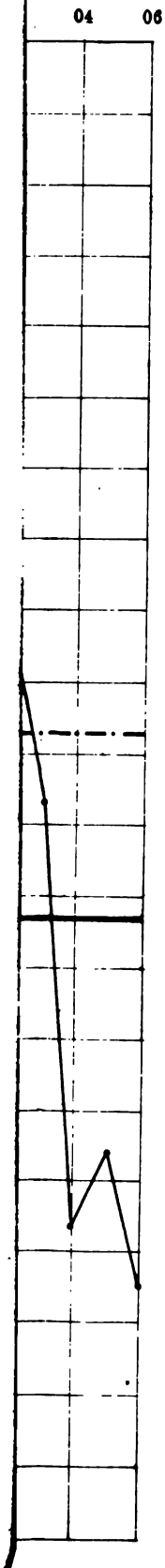
# PLATE III.



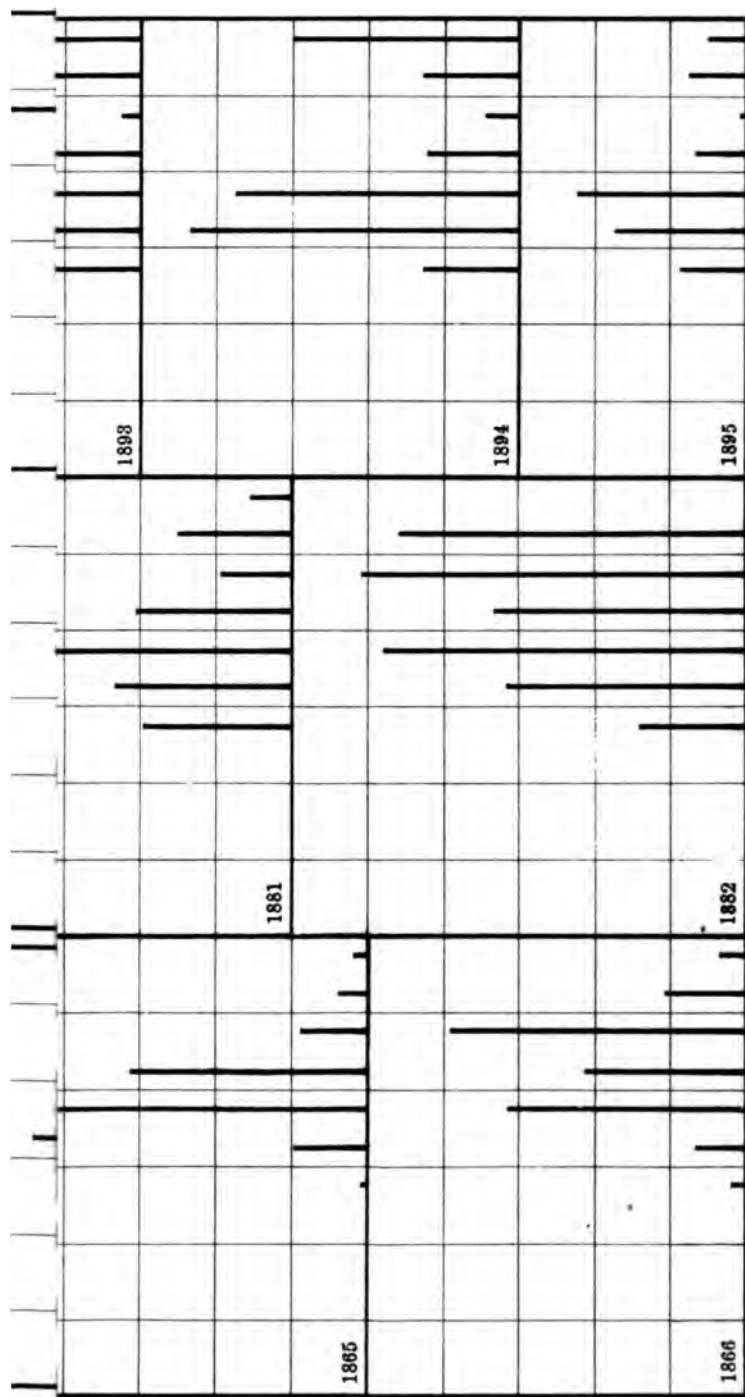




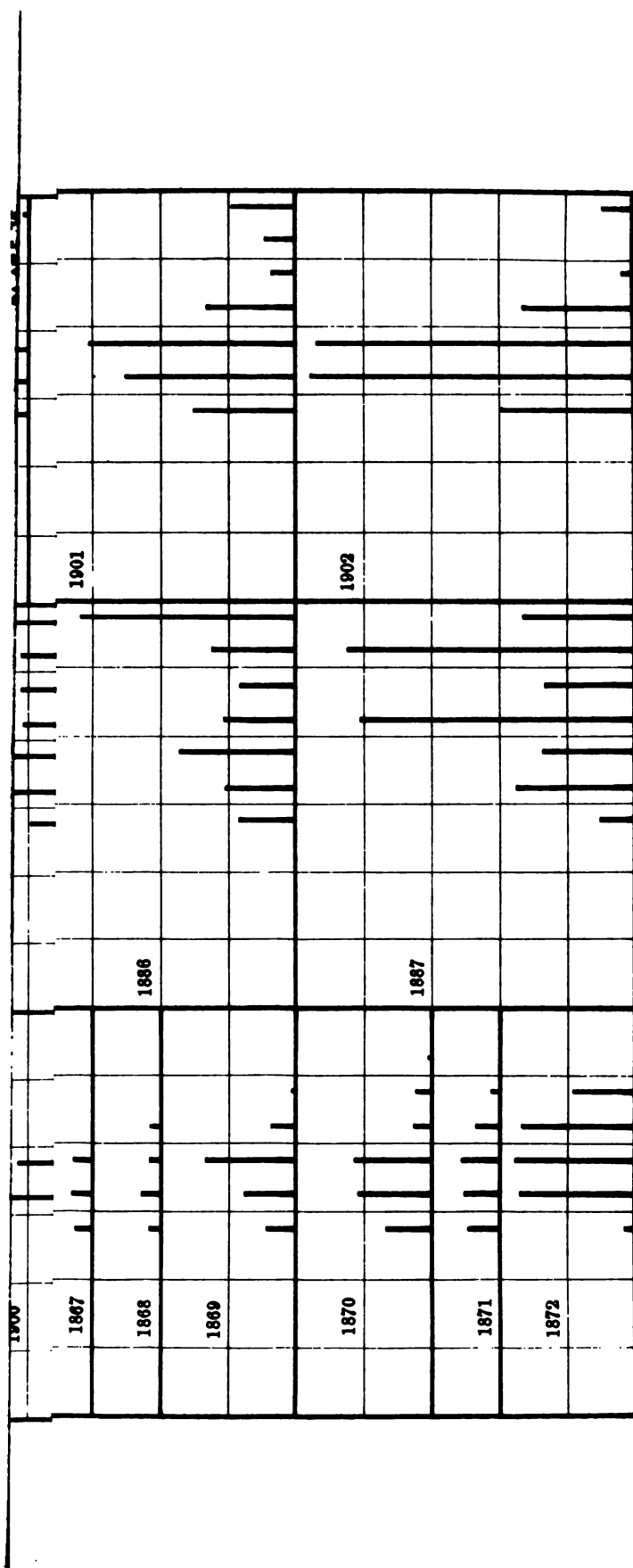
# PLATE IV.



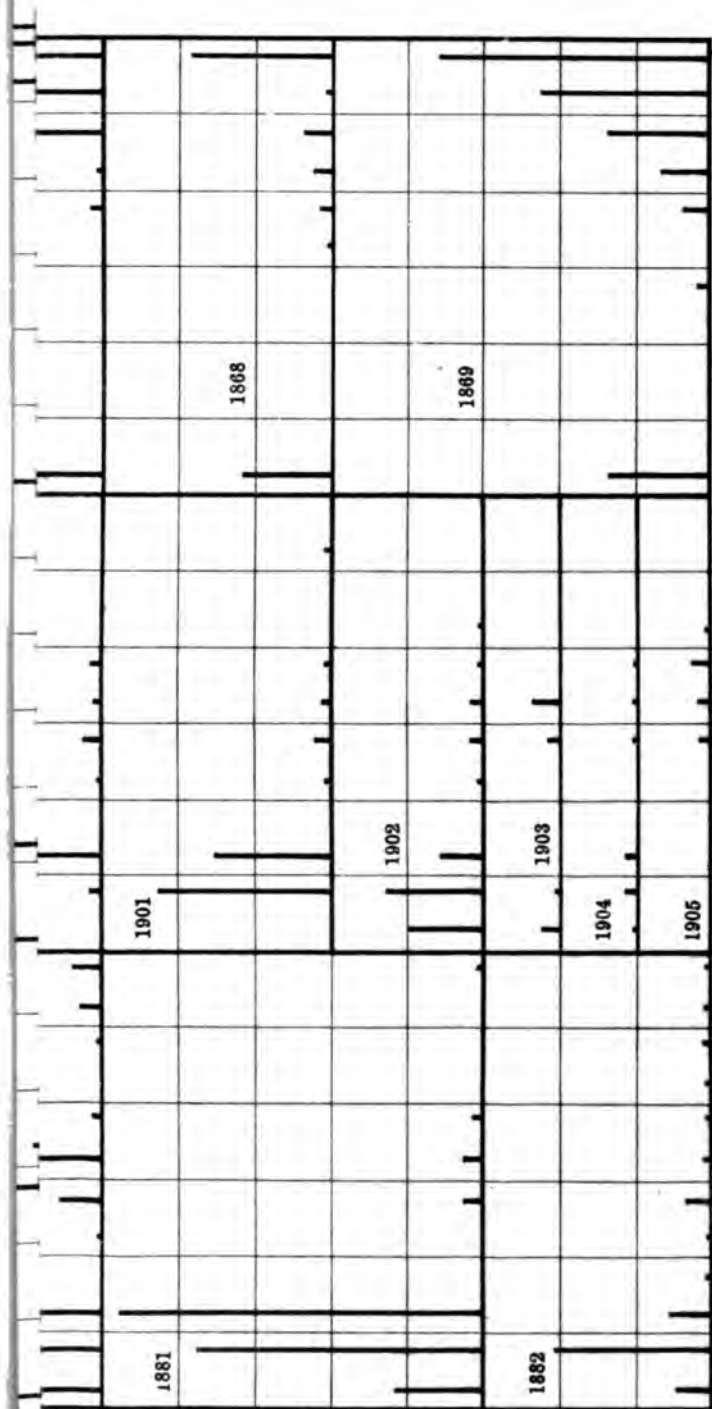


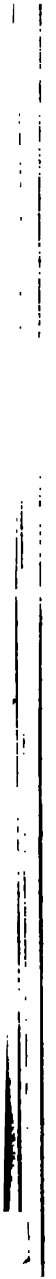








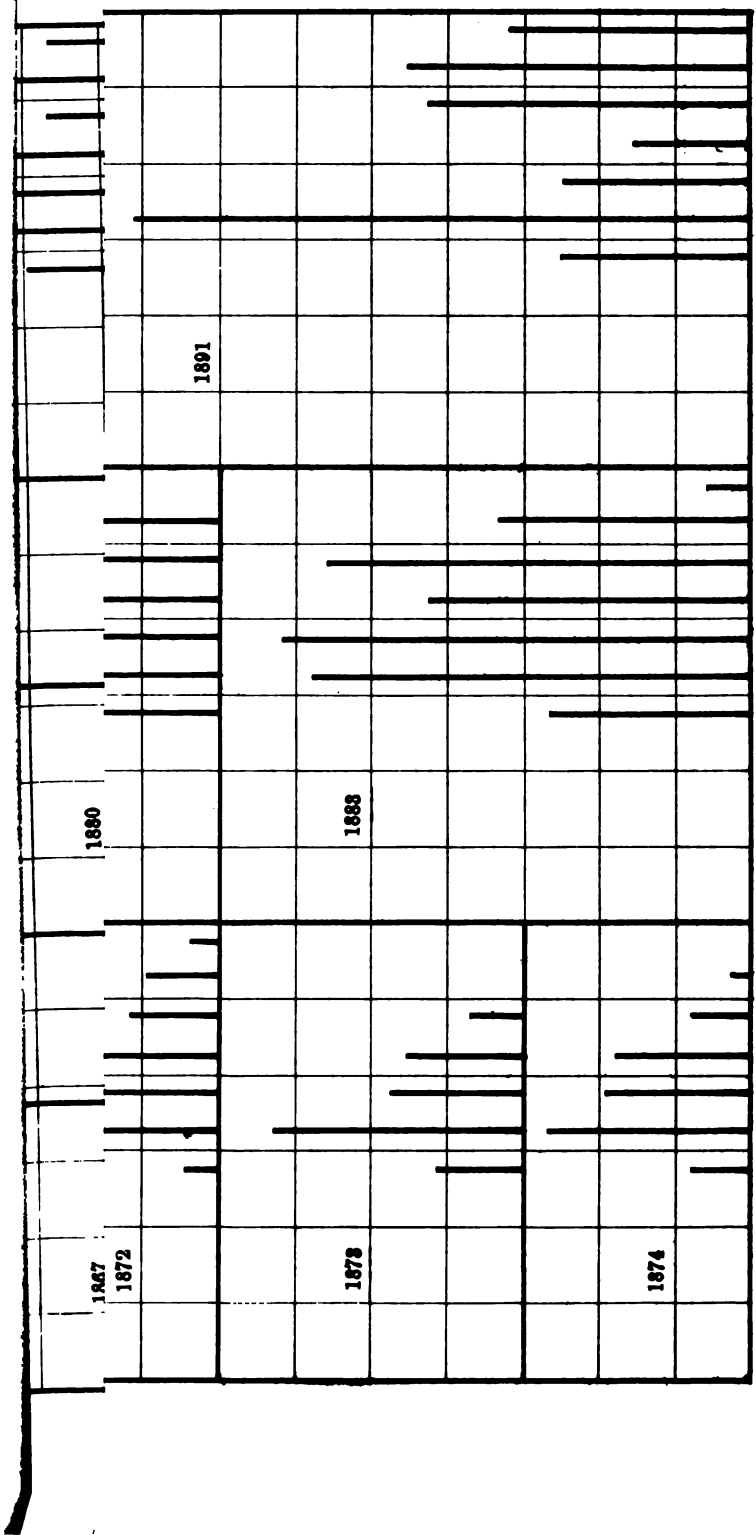






Year	Deaths (approximate)
1868	10
1869	100
1870	10
1871	10
1872	10
1873	10
1874	10
1875	10
1876	10
1877	10
1878	10
1879	10
1880	100
1881	10
1882	100
1883	100
1884	100
1885	10
1886	10
1887	10
1888	10
1889	10
1890	10
1891	10
1892	10
1893	10
1894	10
1895	10
1896	10
1897	10
1898	10
1899	10
1900	10
1901	100
1902	10
1903	10
1904	10
1905	10

1. The first part of the document is a list of the names of the persons who were present at the meeting.





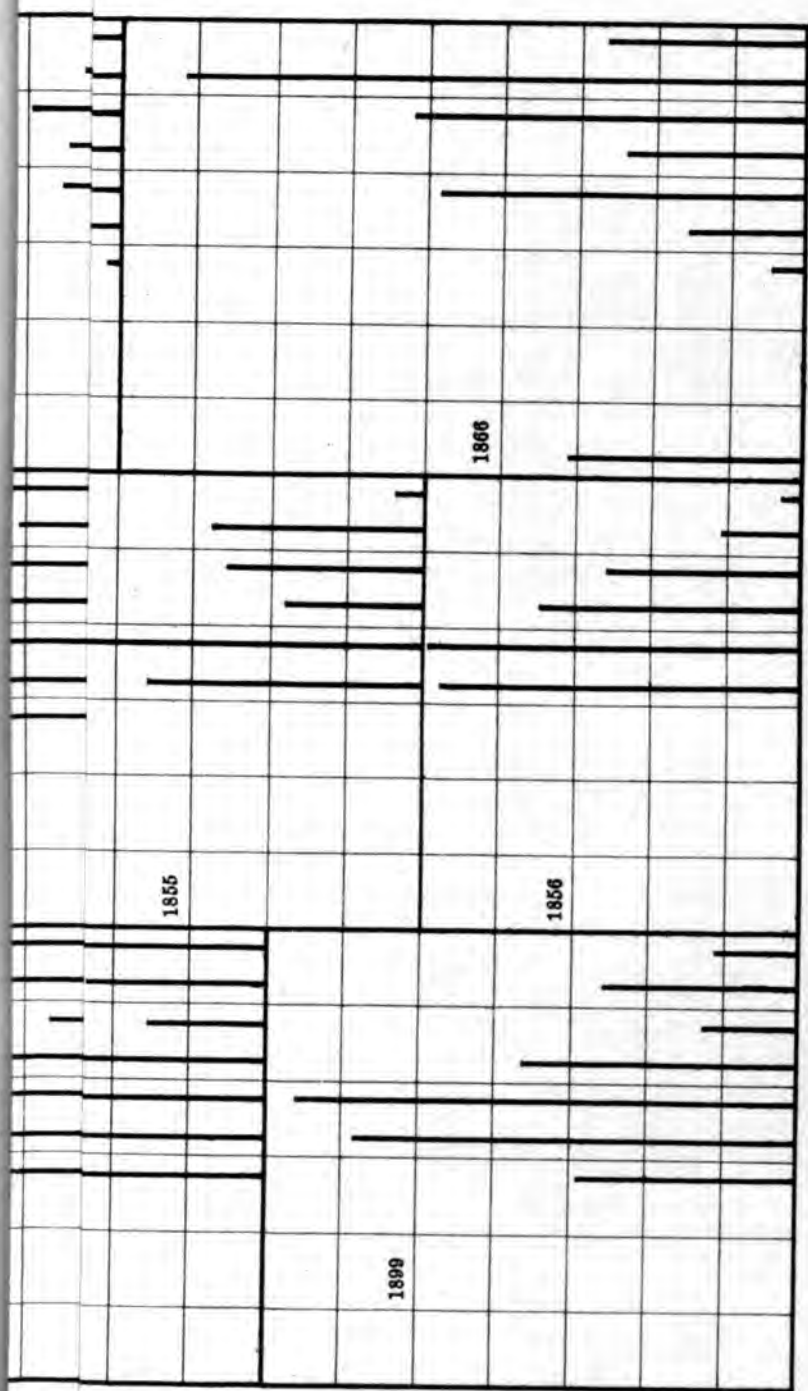
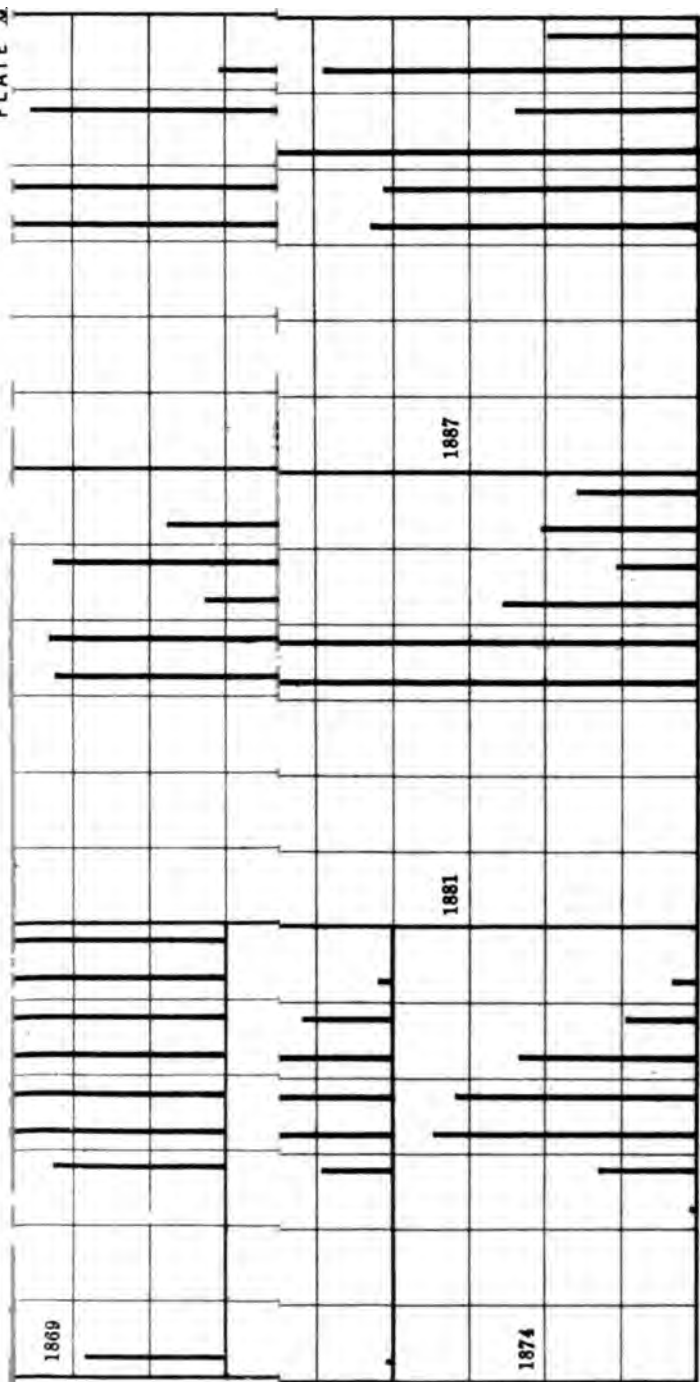




PLATE V.

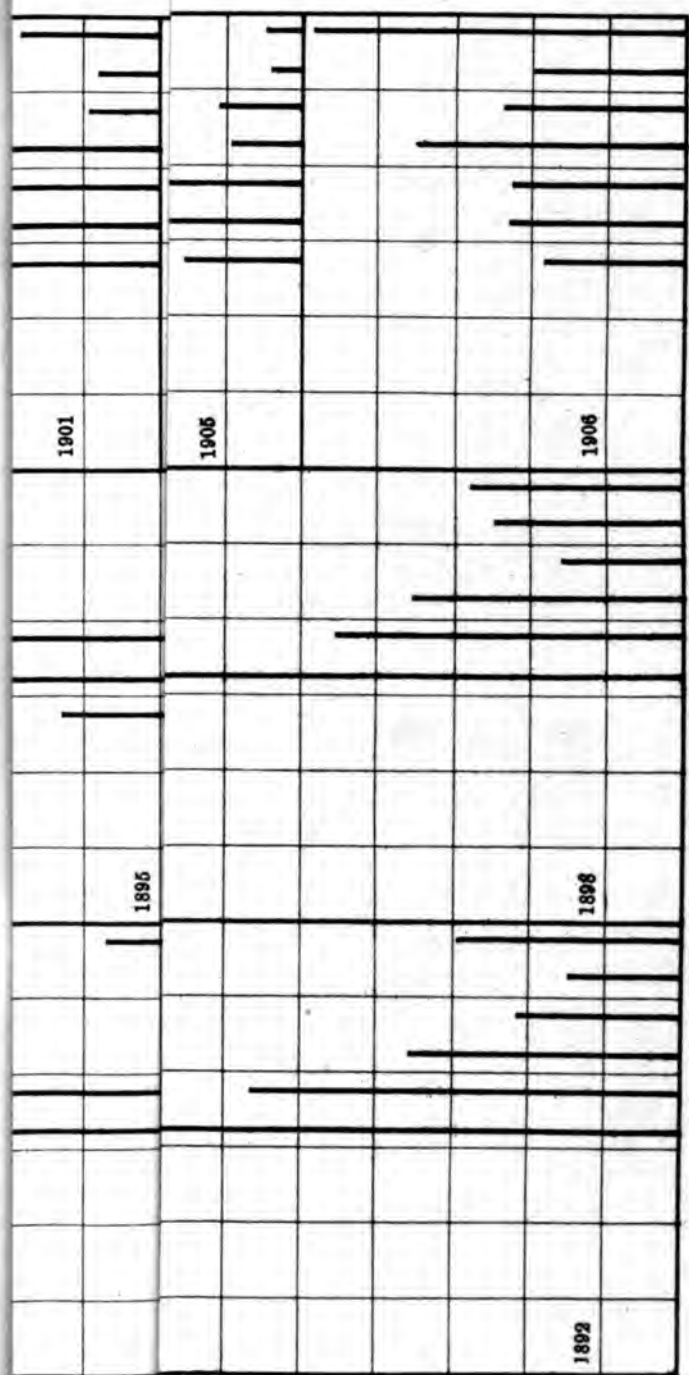


11

12

13







an opportunity for the examination of the question, a table has been prepared (p. 190) in which are shown the catches in the weeks in which the new moon appeared and in the weeks in which there was a full moon, for the years 1860-1900, for the Inveraray district. It appears from the table that on many occasions the catches in the week of full moon were greater than in the following or preceding week in which the moon was new, but it is evident that the opposite was the rule, since the aggregate quantity taken in the weeks of full moon amounted to 215,152 crans, while in the weeks of new moon the aggregate quantity was 293,035 crans. Some are of opinion that the tides really influence the catch of herrings, but a more obvious circumstance is that moonlight renders the nets more visible, and this is especially so with the seine-net, so that quantities of herrings escape capture. It sometimes happens, indeed, that on clear moonlight nights the seine-fishers refrain from shooting their nets or even from going to sea, a fact which has no doubt an important bearing on the figures above quoted.

---

#### EXPLANATION OF PLATES.

PLATE I.—Chart of the Clyde area, showing the localities referred to in the various districts.

PLATES II.-IV.—Diagrams showing the annual fluctuations in the catch of herrings in the various districts, and in the Clyde as a whole, with the mean catch for periods.

PLATES V.-XII.—Diagrams showing, on the same scale throughout, the monthly quantities of herrings taken in each year in the various districts, and in the Clyde as a whole.

TABLE

Showing the total Number of Vessels, including their repeated Voyages, entered Inwards  
the Number of Barrels of Herrings Cured on Shore, and the Total

Year.	AYR, IRVINE, AND SALTCOATS.				CAMBELTOWN.				GLASGOW.				GREENOCK, ETC.			
	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.
	No.	Barrels Cured.			No.	Barrels Cured.			No.	Barrels Cured.			No.	Barrels Cured.		
1809	...	...	...	...	26	3997	14½	4011½	24	2071½	...	2071½	130	23304	67½	23371½
1810	...	...	...	...	36	5581	55	5636	57	4490½	...	4490½	142	29605½	...	29605½
1	30	4374½	...	4374½	29	6033½	32	6065½	70	5320½	...	5320½	136	33150	...	33150
2	43	5857½	...	5857½	41	6186	148	6334	136	9992½	...	9992½	150	32243½	...	32243½
3	44	2373	...	2373	40	688½	82	770½	109	5558	...	5558	162	14333½	...	14333½
4	48	3242½	72½	3315	58	3964½	292	4256½	143	9487	...	9487	174	23603½	...	23603½
5	42	2676	56	2732	38	3538	530	4068	125	10267½	...	10267½	157	24275½	173	24448½
6	25	1968½	19	1987½	45	3673	1849	5522	123	12262	...	12262	163	19263	560	19823
7	39	3128½	...	3128½	69	4767½	1262	6029½	192	17393	24½	17417½	179	23347	655½	24002½
8	42	3274½	103½	3378	59	46 1	786½	5447½	194	17712½	4½	17717	206	25085	104½	25189½
9	50	3496½	37½	3534	48	3739½	1229	4968½	130	9429	24	9453	161	24441	75½	24516½
1820	31	2716½	837	3553½	42	4088½	3588	7676½	142	11235	55	11290	161	26598	725½	27323½
1	43	2236	394½	2630½	50*	2501	1544½	4045½	133	7584½	83½	7663	158	15740½	1075	16815½
2	31	1110	114	1224	40	3371	928	4299	98	5082	54	5136	105	8252	17	8269
3	32	2606	74	2680	31	2615½	1345	3960½	112	6647½	42½	6690	109	12697	154	12851
4	29	2287	...	2287	37	2870	3661	6531	131	9446	152	9598	114	17583½	43½	17637
5	33	1508	...	1508	21	1199	45	1244	99	8657½	8	8665½	83	9980½	...	9980½
6	31	2091½	...	2091½	24	1479	293	1772	121	11651	53	11704	114	11015	...	11015
7	29	2672½	74	2746½	20	1557	369	1926	107	9747½	59	9806½	96	11104	...	11104
8	14	2334½	...	2334½	14	1866½	84	1950½	86	11284½	...	11284½	88	12478½	...	12478½
9	18	3045	...	3045	16	2999½	...	2999½	78	11224	...	11224	86	15072½	...	15072½
1830	11	2723	56	2779	17	1521	621	2142	76	12332	...	12332	90	11722	...	11722
1	15	3434½	...	3434½	17	8582	161	3743	66	8975½	...	8975½	77	13191½	...	13191½
2	23	4653	...	4653	33	4909½	682½	5592	101	12799½	7	12806½	94	16662	...	16662
3	15	3158	...	3158	15	3099½	295	3394½	63	8822½	124	8946½	95	12817½	...	12817½
4	...	...	...	...	13	1844½	205½	2050	45	8109½	...	8109½	73†	10522	75	10597
5	...	...	...	...	9	1163½	282½	1446	39	9404½	...	9404½	61	10092½	...	10092½
6	...	...	...	...	7	1015½	2591	3606½	42	10581	...	10581	75	12294½	...	12294½
7	...	...	...	...	15	1871	2093	3964	49	15045½	...	15045½	77	15281	...	15281
8	...	...	...	...	3	480	2563	3043	32	11689	...	11689	75	16177	210	16387
9	...	...	...	...	...	...	1511	1511	24	8640½	...	8640½	65	17409½	8½	17418
1840	...	...	...	...	3	253	4259	4512	77	18322½	...	18322½	122	28904	260	29164
1	...	...	...	...	2	165	1897	2062	68	18094½	...	18094½	124	28494	150	28644
2	...	...	...	...	...	...	1285	1285	98	17893	...	17893	97	20609	110	20719
3	...	...	...	...	2	254	3482	3736	88	20596	...	20596	85	21412½	1472	22384½
4	...	...	...	...	3	120	1164	1284	43	14196	...	14196	79	15312	732	16044
5	...	...	...	...	14	406	773	1179	44	14470	...	14470	82	16892½	1120	18012½
6	...	...	...	...	5	343	4257	4600	44	15530	...	15530	64	16264½	1365	17629½
7	...	...	...	...	3	298	3703	4001	34	9977	...	9977	46	12428½	3120	15548½
8	...	...	...	...	9	230	2853	3083	44	15454	...	15454	45	11900	482	12382
9	...	...	...	...	6	511	4797	5308	64	15957	...	15957	80	22282½	223	22505½
1850	...	...	...	...	...	...	...	...	34	10362½	...	10362½	57	12298	2000	14298
1	...	...	...	...	...	...	...	...	81	20420	...	20420	65	10409	4093	14502
2	...	...	...	...	...	...	...	...	58	15306	...	15306	73	8859	1786½	10645½
3	...	...	...	...	...	...	...	...	71	25784½	...	25784½	76	13455	339½	13794½
4	...	...	...	...	...	...	...	...	26	12410	...	12410	65	7294	1162	8456
5	...	...	...	...	...	...	...	...	36	18785	23	18808	70	10188½	951	11139½
6	...	...	...	...	...	...	...	...	49	19075	...	19075	55	5666½	929	6595½
7	...	...	...	...	...	...	...	...	17	2354½	...	2354½	47	6349	349	6698
8	...	...	...	...	...	...	...	...	14	3366	...	3366	45	9781	1005	10786
9	...	...	...	...	...	...	...	...	12	18555	...	18555	43	6788	1102	7890

\* Now includes Islay. † Now includes Ayr, Irvine, &c. ‡ From 5th April 1844 to 5th Jan. 1845.

§ Year now ends 31st December.

NOTE.—From 1809 to 1843 the year ended on 5th April; in 1844, only nine months are included, viz., from 5th

I

from the Fishery, with the Number of Barrels of Herrings Cured on Board; also, Number Cured, in the Firth of Clyde Districts, in each year 1809-1906.

Year.	INVERARAY.				ROTHESAY.				STRANRAER AND DUMFRIES.				TOTAL.			
	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.
	No.	Barrels Cured.			No.	Barrels Cured.			No.	Barrels Cured.			No.	Barrels Cured.		
1809	10	396½	1688	2084½	122	14245	145	14390	...	...	...	...	312	44014	1915	45929
1810	15	1712	3058	4770	132	23043	33	23076	...	...	...	...	382	64432	3146	67578
1	23	2334	3233½	5567½	89	20904½	...	20904½	...	...	...	...	377	72117½	3265½	75383
2	12	1286½	4012½	5299½	113	26392	...	26392	...	...	...	...	495	81958	4160½	86118½
3	24	1284	4212½	5496½	136	7092	347	7439	9	932	694½	1626½	524	32261	5336	37597
4	42	2680	6160	8840	123	16030½	617½	16647½	12	851	2513	3364	600	59859	9635	69514
5	38	2977½	9057	12034½	86	9170	558	9728	8	482	1566	2048	494	53386½	11940	65526½
6	34	3014½	3928	6942½	73	7474	323	7797	7	416	2212½	2628½	470	48071	8891½	56962½
7	28	2109½	4268½	6378	109	13767	674½	14441½	13	938	932	1870	629	65450½	7817	73267½
8	25	1794	3920	5714	91	9675½	910½	10586	17	1496	268½	1764½	634	63698½	6097½	69796
9	23	2491½	4274½	6766	69	12290½	470½	12761	18	1656½	171½	1828	498	57544½	6282½	63827
1820	26	4311	2328	6639	90	16368	2397	18765	23	2842½	491	3333½	515	68159½	10421½	78581
1	20	3632	1467	5099	81	10629	1204	11833	30*	734	182	916	515	43057	5950½	49007½
2	10	761	1302½	2063½	56	7006	1064	8070	28	725½	257	982½	368	26307½	3736½	30044
3	14	1180	1225½	2405½	57	9771	2035	11806	29	3411	2380	5791	384	38928	7256	46134
4	9	1691	998	2689	61	14837½	352	15189½	19	2340	32½	2372½	400	51055	5239	56294
5	13	381½	1331	1712½	50	12280	100	12380	11	1203	...	1203	310	35209½	1484	36693½
6	9	965	2304½	3269½	63	9050½	229½	9280	10	1128½	159	1287½	372	37380½	3039	40419½
7	6	653½	1819	2472½	42	11530	207	11737	14	1807½	472	2279½	314	39072	3000	42072
8	5	659	1248	1907	44	12234½	...	12234½	10	1311	168	1479	261	42168½	1500	43668½
9	10	1959	1555½	3514½	51	16399	...	16399	12	1998	80	2078	271	52697	1635½	54332½
1830	7	816½	1453	2269½	41	9698½	...	9698½	9	1820	854	2674	251	40633	2984	43617
1	5	625	1635	2260	36	9134	...	9134	10	2178½	...	2178½	226	41121	1796	42917
2	9	1190	3708	4898	54	19943	30	19973	12	3219	...	3219	326	63376	4427½	67803½
3	6	959½	3627½	4587	52	20482½	79	20561½	15	3343	...	3343	261	52682½	4125½	56808
4	7	1128½	2652½	3761	40	15316	105	15421	17	3261½	...	3261½	195	40182	3018	43200
5	3	683	2307	2990	41	16881	2550	19431	8	1910	...	1910	161	40134½	5139½	45274
6	4	676	3658½	4334½	40	15826	3265	19091	9	1769½	...	1769½	177	42162½	9514½	51677
7	2	354	7444½	7798½	50	19942	...	19942	7	1564	...	1564	200	54057½	9537½	63595
8	3	863½	7040½	7904	43	20145	2802½	22947½	11	2562	...	2562	167	51916½	12616	64532½
9	1	303	2922	3225	33	17119	...	17119	6	1665	...	1665	129	45137	4441½	49578½
1840	9	3539	4022½	7561½	46	18401	...	18401	11	3075	...	3075	268	72494½	8541½	81036
1	9	1928	6370½	8298½	40	14843½	...	14843½	8	2415	...	2415	251	65940	8417½	74357½
2	6	2957	3531½	6488½	31	10127	234	10361	9	2476	...	2476	241	54062	5160½	59222½
3	9	4845½	4036½	8882	31	11678	309	11987	7	2084	...	2084	222	60870	9299½	70169½
4	9	4415½	4588½	9004	33	9699	110	9809	12	2764	...	2764	179	46506½	6594½	53101
5	11	4782½	4201	8983½	36	9109	454	9563	14	2965	835	3800	201	48625	7383	56008
6	10	3436	6567½	10003½	25	5845	289	6134	13	3294	1152	4446	161	44712½	13630½	58343
7	9	2666	5191	7857	23	4646	244	4890	8	1884	671	2555	123	31899½	12929	44828½
8	7	1783½	4244½	6028	20	3228½	...	3228½	9	1813½	1530½	3344	134	34409½	9110	43519½
9	8	1624½	13985	15609½	44	9496½	...	9496½	7	1933	1275	3208	209	51804½	20280	72084½
1850	17	1473½	16149½	17623	26	6047½	...	6047½	...	...	...	...	134	30181½	18149½	48931
1	36	8697	26628	35325	27	4364	949	5313	...	...	...	...	209	43890	31670	75560
2	20	450½	11804	12254½	11	847	1370	2217	...	...	...	...	162	25462½	14960½	40423
3	38	1864½	21874½	23739	24	2226½	3828	6054½	...	...	...	...	209	43330½	26042	69372½
4	44	1579½	19053	20632½	26	1412	987½	2399½	...	...	...	...	161	22695½	21202½	43898
5	30	2238	26558½	28796½	29	1574	3500	5074	...	...	...	...	165	32785½	31032½	63818
6	45	4201	31005½	35206½	27	1940	2433	4373	...	...	...	...	176	30882½	34367½	65250
7	45	8020	21132	29152	25	2629½	2506	5135½	...	...	...	...	134	19353	23987	43340
8	45	9155	22398	31553	20	3386½	1885	5271½	...	...	...	...	124	26688½	25288	50976½
9	41	2688	26062	28750	23	1654	2193	3847	...	...	...	...	119	29685	29357	59042

\* Now includes Dumfries.

† Now includes Campbeltown.

April to 5th January 1845; from 1845 to 1851 the year ended on 5th Jan., and from 1852 it ended on 31st Dec.



continued.

fishery, with the Number of Barrels of Herrings Cured on Board ; also, the Number of Barrels of the Firth of Clyde Districts, in each year 1869-1906.

Year.	INVERARAY.				ROTHESAY.				STRANRAER AND DUMFRIES.				TOTAL.			
	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.	Vessels.		Barrels Cured on Shore.	Total Barrels Cured.
	No.	Barrels Cured.			No.	Barrels Cured.			No.	Barrels Cured.			No.	Barrels Cured.		
1860	50	3225	29532	32757	26	698	6721	7419	...	...	...	...	134	23697	37868	61565
1	51	3702	19104	22807	9	931	1517	2448	...	...	...	...	99	19694	20848	40543
2	68	8446	46715	55161	15	1513	2512	4025	...	...	...	...	146	41634	49789	91423
3	37	1089	18350	19439	14	3079	1832	4911	14	1341	...	1341	94	16591	22397	38988
4	36	2212	13593	15805	23	4878	22263	27141	13	2195	...	2195	118	24591	38678	63269
5	34	412	23784	24196	30	918	25260	26178	14	1914	1015	2929	139	22615	53297	75912
6	58	2796	24720	27516	34	3434	28757	32191	21	1579	382	1961	182	26465	56531	82997
7	58	3563	33134	36697	21	4313	24200	28513	14	2222	...	2222	146	29130	67863	96993
8	33	1659	41697	43356	17	2357	8712	11069	19	1711	...	1711	102	24097	113955	138053
9	41	8376	30838	39214	17	1466	15230	16696	19	1368	...	1368	100	35301	83794	119095
1870	29	1444	20066	21510	13	1308	16996	18304	11	1003	27	1030	65	17838	47019	64857
1	42	18056	11396	29452	10	874	8890	9764	12	1146	...	1146	73	36619	29372	65991
2	22	2445	7940	10385	6	493	10746	11239	8	277	...	277	46	7114	25294	32408
3	22	4487	5785	10272	8	576	3388	3964	8	687	...	687	47	9409	26417	35826
4	25	1307	5828	7135	10	985	2842	3827	11	278	451	729	54	7068	28536	35604
5	22	1098	13257	14355	15	673	3757	4430	5	929	9647	10576	57	6089	33860	39949
6	16	17058	14125	31183	15	486	5810	6296	4	490	6071	6561	40	19926	39219	59145
7	28	14119	9213	23332	9	315	3168	3483	6	433	10254	10687	51	17077	42382	59460
8	44	3655	10145	13800	12	692	1637	2329	3	350	17493	17843	67	8752	48145	66898
9	26	15900	17936	33837	10	189	7243	7432	3	128	25300	25428	54	20655	89085	109740
1880	21	23439	6754	30193	13	548	10137	10685	1	114	31292	31406	47	31978	94951	126929
1	24	25445	14574	40019	6	1063	3403	4466	...	...	17390	17390	39	35244	60477	95721
2	32	29495	55359	84854	9	1009	10107	11116	...	...	13401	13401	51	46818	136057	182875
3	13	32888	18606	51494	6	265	3069	3334	...	...	26501	26501	22	45160	101174	146335
4	15	11404	10111	21515	12	687	3640	4327	...	...	14019	14019	31	24130	72609	96731
5	7	11129	15250	26379	6	503	2962	3465	...	...	27671	27671	17	19525	99117	118642
6	2	314	18091	18405	1	11	2039	2050	...	...	4760	4760	7	2906	66527	69433
7	1	10	15808	15818	3	129	1795	1924	...	...	9881	9881	8	4477	84162	88639
8	3	364	20794	21158	3	121	1179	1300	...	...	9696	9696	8	9989	80901	90890
9	...	...	30702	30702	5	600	594	1194	...	...	7788	7788	10	18166	84967	103133
1890	...	...	1060	1060	7	719	621	1340	...	...	1322	1322	9	6478	7773	14251
1	...	...	1763	1763	4	505	962	1467	...	...	490	490	7	29000	19654	48654
2	...	...	1166	1166	4	...	550	550	...	...	140	140	8	...	12802	12802
3	...	8	1441	1449	3	...	345	345	...	...	...	...	5	92	16149	16241
4	...	31	1763	1794	...	...	962	962	...	...	490	490	...	954	19654	20608
5	...	...	116	116	...	...	165	165	...	...	...	...	...	...	1483	1483
6	...	...	244	244	4	...	399	399	...	...	...	...	12	...	12338	12338
7	...	2709	9423	12132	3	308	646	954	...	...	...	...	10	3097	32207	35304
8	...	2015	1197	3212	...	...	...	...	...	...	...	...	...	2015	18949	20964
9	...	38	886	924	2	553	1204	1757	...	...	...	...	2	591	30286	30877
1900	...	...	1876	1876	2	508	582	1090	...	...	80	80	7	508	28902	29410
1	...	14	1292	1306	2	291	643	934	...	...	135	135	6	374	29195	29569
2	...	...	3110	3110	...	240	2865	3105	...	...	135	135	2	240	37360	37600
3	...	...	3185	3185	3	154	1502	1656	...	...	95	95	5	154	34782	34936
4	...	...	184	184	...	...	505	505	...	...	27	27	...	...	21031	21031
5	...	...	318	318	...	...	182	182	...	...	108	108	...	...	28537	28537
6	...	...	2335	2335	...	...	773	773	...	...	57	57	...	...	26976	26976

\* Now excludes Campbeltown.

TABLE

Showing the Number of Boats, whether decked or undecked, employed in the Firth of Clyde and Boys by whom the said Boats were manned, together with the Number of

Year.	AYR, IRVINE, AND SALTCOATS.				CAMPBELTOWN.				GLASGOW.				GREENOCK.			
	Number of			Total Persons Employed.	Number of			Total Persons Employed.	Number of			Total Persons Employed.	Number of			Total Persons Employed.
	Boats.	Men and Boys.	Fish Curers.		Boats.	Men and Boys.	Fish Curers.		Boats.	Men and Boys.	Curers. Fish		Boats.	Men and Boys.	Fish Curers.	
1825	82	275	34	509	190	593	37	917	...	...	4	96	300	900	20	2070
6	99	441	36	619	187	578	52	936	...	...	4	112	285	855	17	2021
7	138	545	32	744	216	607	57	976	...	...	3	121	264	792	21	2000
8	138	545	32	748	212	610	67	952	...	...	4	137	250	750	21	1992
9	126	472	29	684	226	666	73	1020	...	...	4	156	245	725	19	1856
1830	125	464	30	679	261	771	71	1181	...	...	3	155	240	710	25	1781
1	90	331	24	502	265	878	71	1204	...	...	3	159	240	720	27	1793
2	92	341	28	509	272	1015	70	1239	...	...	5	150	247	741	26	1828
3	88	324	25	522	339	1166	86	1445	...	...	5	158	264	792	25	1847
4	...	...	...	...	367	1199	78	1457	...	...	4	137	352	1116	50	2369
5	...	...	...	...	379	1240	87	1502	...	...	4	132	365	1144	44	2349
6	...	...	...	...	400	1281	113	1587	...	...	5	135	387	1199	41	2465
7	...	...	...	...	392	1214	77	1448	...	...	6	152	375	1110	36	2374
8	...	...	...	...	410	1271	66	1503	...	...	5	152	370	1076	25	2138
9	...	...	...	...	505	1599	62	1839	...	...	5	139	383	1110	31	2299
1840	...	...	...	...	517	1643	76	1919	...	...	6	154	455	1291	38	2892
1	...	...	...	...	518	1642	59	1899	...	...	7	161	504	1437	48	3203
2	...	...	...	...	422	1558	48	2028	...	...	7	160	489	1209	32	2506
3	...	...	...	...	462	1637	81	2601	...	...	7	163	518	1280	46	2401
4	...	...	...	...	468	1658	75	2510	...	...	9	164	471	1194	43	2048
5	...	...	...	...	583	1806	75	2671	...	...	7	167	476	1183	45	1972
6	...	...	...	...	588	1836	135	2778	...	...	8	155	491	1170	38	2033
7	...	...	...	...	589	1890	121	2772	...	...	10	147	493	1172	30	1982
8	...	...	...	...	546	1930	129	2644	...	...	9	137	478	1200	35	1829
9	...	...	...	...	517	1806	111	2391	...	...	9	142	496	1302	34	1984
1850	...	...	...	...	...	...	...	...	48	97	13	261	539	1603	26	2422
1	...	...	...	...	...	...	...	...	45	88	16	251	592	1827	32	2463
2	...	...	...	...	...	...	...	...	45	88	18	239	603	1893	29	2517
3	...	...	...	...	...	...	...	...	47	92	19	255	587	1883	34	2537
4	...	...	...	...	...	...	...	...	41	82	20	244	591	1828	33	2530
5	...	...	...	...	...	...	...	...	35	78	19	593	581	1608	31	2963
6	...	...	...	...	...	...	...	...	28	60	21	577	585	1545	32	2711
7	...	...	...	...	...	...	...	...	26	60	20	576	562	1413	31	2529
8	...	...	...	...	...	...	...	...	23	60	20	?	551	1276	34	?
9	...	...	...	...	...	...	...	...	21	52	20	...	542	1212	32	...
1860	...	...	...	...	...	...	...	...	21	39	20	...	506	1099	36	...
1	...	...	...	...	...	...	...	...	21	39	20	...	510	1097	32	...
2	...	...	...	...	...	...	...	...	21	40	20	...	498	1082	42	...
3	...	...	...	...	370	1112	36	...	21	39	20	...	188	425	17	...
4	...	...	...	...	412	1187	36	...	29	69	27	...	186	427	20	...
5	...	...	...	...	407	1140	46	...	37	107	27	...	191	475	25	...
6	...	...	...	...	433	1229	47	...	32	110	27	...	189	469	30	...
7	...	...	...	...	455	1278	48	...	30	100	29	...	192	469	26	...
8	...	...	...	...	448	1214	45	...	32	100	29	...	188	525	18	...
9	...	...	...	...	453	1123	48	...	110	280	29	...	421	935	22	...

\* The total includes the fishermen and fish-curers, and also the following:—(1) The number of coopers number of labourers. After 1893 it includes also fishmongers, hawkers of fish, clerks, persons gathering persons employed on board vessels, curing, exporting, and carrying herrings and other fish, or importing



[

istricts in the Shore-curing Herring and Cod and Ling Fisheries, with the Number of Men  
ish-curers, and the Total Number of Persons employed\* in each year 1825-1906.

Year.	INVERARAY.				ROTHESAY.				STRANRAER, &C.				TOTALS.			
	Number of			Total Persons Employed.	Number of			Total Persons Employed.	Number of			Total Persons Employed.	Number of			Total Persons Employed.
	Boats.	Men and Boys.	Fish Curers.		Boats.	Men and Boys.	Fish Curers.		Boats.	Men and Boys.	Fish Curers.		Boats.	Men and Boys.	Fish Curers.	
1825	335	1006	39	1369	246	768	22	1023	143	553	46	673	1296	4094	202	6657
6	346	1038	71	1525	243	758	24	980	152	589	42	701	1424	4515	256	7531
7	367	1101	71	1631	287	861	22	1246	152	609	50	813	1312	4259	246	6894
8	377	1100	78	1556	275	825	17	1195	128	538	51	782	1380	4363	265	7342
9	375	1095	69	1596	273	819	16	1195	132	607	54	872	1377	4384	264	7379
1830	370	1080	67	1579	279	837	15	1202	147	655	56	963	1423	4521	272	7571
1	371	1085	60	1521	276	828	16	1176	92	400	9	509	1334	4242	210	6864
2	403	1203	66	1689	279	837	18	1195	94	402	8	507	1387	4539	221	7117
3	419	1244	61	1770	289	867	15	1219	76	294	11	479	1475	4687	228	7440
4	418	1254	55	1769	301	903	16	1256	74	381	11	542	1532	4853	214	7530
5	425	1275	58	1786	299	897	16	1250	68	302	7	451	1536	4858	211	7470
6	441	1303	30	2057	297	891	17	1244	56	312	7	459	1581	4936	213	7947
7	451	1353	32	2116	300	917	19	1266	79	414	6	564	1597	5008	176	7920
8	454	1362	29	2143	299	908	30	981	78	317	6	391	1581	4834	161	7258
9	454	1362	26	2140	263	786	34	931	84	430	4	508	1689	5287	162	7856
1840	1020	2893	32	4382	269	816	33	946	90	433	7	547	2351	7076	192	10840
1	1028	2917	37	4512	278	845	36	972	88	378	6	491	2416	7219	193	11238
2	1074	3077	58	4720	289	897	36	990	94	486	5	551	2368	7177	181	10955
3	1080	3076	35	4704	278	875	41	1057	191	620	4	881	2529	7538	214	11807
4	1120	3196	36	4825	278	848	35	963	191	620	7	895	2528	7516	205	11426
5	1150	3306	40	4950	281	848	27	1034	205	633	11	941	2695	7776	205	11735
6	1201	3529	41	5283	233	832	27	967	205	633	11	942	2718	8000	260	12163
7	1268	3916	34	5487	232	701	24	826	208	680	6	1009	2790	8359	225	12223
8	1283	4024	38	5634	219	779	15	839	208	680	9	1012	2734	8613	238	12695
9	1283	4024	16	5612	217	814	35	902	219	703	8	1048	2732	8649	213	12079
1850	1445	4689	142	6574	227	855	30	955	...	...	...	...	2259	7244	211	10212
1	1445	4689	142	6574	231	702	31	813	...	...	...	...	2313	7306	221	10101
2	1185	3838	67	5260	495	1616	100	2289	...	...	...	...	2328	7435	214	10306
3	1086	3292	70	4536	567	1727	73	2291	...	...	...	...	2287	6994	196	9619
4	1062	3189	65	4368	561	1624	76	2118	...	...	...	...	2255	6723	194	9260
5	1045	3084	70	4442	557	1654	66	2822	...	...	...	...	2318	6424	186	10822
6	1024	3025	82	4320	534	1613	62	2632	...	...	...	...	2171	6243	197	10240
7	1023	3022	74	4387	554	1684	40	2668	...	...	...	...	2165	6179	185	10160
8	999	2915	74	?	562	1723	36	...	...	...	...	...	2135	5974	164	...
9	1072	2944	105	...	553	1816	43	...	...	...	...	...	2188	6024	200	...
1860	995	2898	80	...	542	1816	29	...	...	...	...	...	2064	5652	165	...
1	1071	2871	84	...	520	1727	32	...	...	...	...	...	2122	5534	168	...
2	1114	2578	111	...	509	1511	28	...	...	...	...	...	2142	5211	201	...
3	1046	2446	73	...	296	794	29	...	308	634	12	...	2229	5500	187	...
4	1135	2648	83	...	292	766	48	...	316	697	13	...	2371	5794	227	...
5	1150	2678	91	...	287	659	49	...	320	710	17	...	2392	5769	255	...
6	1181	2744	107	...	282	668	42	...	337	756	17	...	2464	5976	270	...
7	1273	2801	130	...	357	697	37	...	340	760	18	...	2647	6105	288	...
8	1370	2977	153	...	376	787	31	...	347	773	18	...	2763	6376	294	...
9	872	1915	127	...	476	1073	31	...	351	793	15	...	2685	6119	272	...

1) the number of persons employed in gutting, packing, re-packing, cleaning, or drying the fish; (3) the  
nit and baiting lines, boat-builders, persons making and mending nets, persons manufacturing barrel staves,  
dit, stave wood, and hoops.

TABLE II.—

Showing the Number of Boats, whether decked or undecked, employed in the Firth of Clyde and Boys by whom the said Boats were manned, together with the Number of

Year.	AYR, IRVINE, AND SALTCOATS.				CAMPBELTOWN.				GLASGOW.				GREENOCK.			
	Number of			Total Persons Employed.	Number of			Total Persons Employed.	Number of			Total Persons Employed.	Number of			Total Persons Employed.
	Boats.	Men and Boys.	Fish Curers.		Boats.	Men and Boys.	Fish Curers.		Boats.	Men and Boys.	Fish Curers.		Boats.	Men and Boys.	Fish Curers.	
1870	...	...	...	...	473	1088	41	1565	159	360	29	1166	408	829	16	1311
1	...	...	...	...	481	1098	43	1573	137	342	25	1145	371	705	15	443
2	...	...	...	...	489	1178	42	1646	136	360	24	1158	346	602	11	1054
3	...	...	...	...	497	1187	46	1704	119	305	24	1069	297	514	11	954
4	...	...	...	...	491	1174	46	1679	106	291	24	1077	285	487	12	924
5	...	...	...	...	499	1226	37	1676	...	...	...	...	339	656	38	1709
6	...	...	...	...	499	1312	35	1749	...	...	...	...	308	599	32	1623
7	...	...	...	...	541	1324	35	1806	...	...	...	...	325	580	27	1572
8	...	...	...	...	557	1526	38	1969	...	...	...	...	283	549	28	1509
9	...	...	...	...	615	1603	39	2124	...	...	...	...	292	541	28	1505
1880	...	...	...	...	639	1607	45	2137	...	...	...	...	299	541	27	1522
1	...	...	...	...	592	1584	36	2132	...	...	...	...	316	524	29	1520
2	...	...	...	...	631	1623	39	2217	...	...	...	...	318	528	31	1518
3	...	...	...	...	672	1746	40	2358	...	...	...	...	311	522	31	1507
4	...	...	...	...	693	1729	42	2447	...	...	...	...	306	499	33	1480
5	...	...	...	...	705	1798	37	2470	...	...	...	...	294	457	38	1405
6	...	...	...	...	682	1776	55	2519	...	...	...	...	305	435	31	1415
7	...	...	...	...	698	1790	50	2608	...	...	...	...	306	458	33	1859
8	...	...	...	...	646	2185	44	2956	...	...	...	...	286	459	34	2258
9	...	...	...	...	625	2061	50	2886	...	...	...	...	270	427	32	1635
1890	...	...	...	...	632	1978	51	2869	...	...	...	...	241	412	32	2164
1	...	...	...	...	633	1797	56	2865	...	...	...	...	228	387	32	2166
2	...	...	...	...	635	1676	50	?	...	...	...	...	313	451	31	?
3	...	...	...	...	566	1486	33	?	...	...	...	...	307	493	31	?
4	...	...	...	...	592	1461	32	2770	...	...	...	...	303	488	27	3757
5	...	...	...	...	582	1419	24	2521	...	...	...	...	303	564	22	4010
6	...	...	...	...	463	893	7	1364	...	...	...	...	287	579	19	4580
7	...	...	...	...	377	865	10	1377	...	...	...	...	292	593	28	4799
8	...	...	...	...	382	860	12	1406	...	...	...	...	328	602	28	5470
9	...	...	...	...	384	828	11	1352	...	...	...	...	317	540	30	4838
1900	...	...	...	...	386	810	9	1368	...	...	...	...	337	579	30	4144
1	...	...	...	...	342	795	10	1185	...	...	...	...	337	579	28	4129
2	...	...	...	...	379	780	10	1179	...	...	...	...	278	514	28	4375
3	...	...	...	...	373	775	12	1118	...	...	...	...	268	491	27	4363
4	...	...	...	...	385	771	17	994	...	...	...	...	239	471	27	4391
5	...	...	...	...	365	760	16	1065	...	...	...	...	216	415	34	4391
6	...	...	...	...	358	752	15	1000	...	...	...	...	221	398	34	4418

\* The total includes the fishermen and fish-curers, and also the following:—(1) The number of coopers, number of labourers. After 1893 it includes also fishmongers, hawkers of fish, clerks, persons gathering persons employed on board vessels, curing, exporting, and carrying herrings and other fish, or importing

continued.

Districts in the Shore-curing Herring and Cod and Ling Fisheries, with the Number of Men fish-curers, and the Total Number of Persons employed \* in each year 1825-1906.

Year.	INVERARAY.					ROTHESAY.					STRANRAER, &c.					TOTALS.				
	Number of				Total Persons Employed.	Number of				Total Persons Employed.	Number of				Total Persons Employed.	Number of				Total Persons Employed.
	Boats.	Men and Boys.	Fish Curers.			Boats.	Men and Boys.	Fish Curers.			Boats.	Men and Boys.	Fish Curers.			Boats.	Men and Boys.	Fish Curers.		
1870	968	2172	103		2870	524	1099	30		1846	497	888	11		1466	3029	6436	230		10224
1	962	2160	96		2816	568	1150	24		1898	479	849	8		1400	2998	6304	211		9275
2	953	2100	84		2731	579	1150	14		1885	480	849	6		1398	2983	6239	181		9872
3	934	2050	70		2624	563	1114	13		1762	485	852	6		1424	2896	6022	170		9537
4	862	1919	51		2454	553	1094	18		1732	475	827	10		1447	2772	5792	161		9313
5	823	1889	45		2406	535	1000	25		1584	480	831	8		1460	2676	5602	153		8835
6	809	1855	48		2558	498	816	27		1381	501	845	10		1513	2615	5427	152		8824
7	792	1818	35		2517	467	751	22		1194	544	901	13		1656	2669	5374	132		8744
8	750	1738	41		2067	442	677	19		985	556	926	73		1753	2588	5416	199		8283
9	690	1647	35		2110	418	657	21		993	569	952	78		1879	2584	5400	201		8611
1880	693	1648	39		2107	428	686	21		1007	591	958	86		1908	2650	5440	218		8681
1	692	1640	43		2128	429	684	15		970	609	976	93		1959	2638	5408	216		8709
2	711	1653	44		2142	434	695	22		1033	604	983	82		1957	2698	5482	218		8867
3	699	1557	39		1978	385	684	21		1013	614	999	96		2069	2643	5424	205		8836
4	684	1467	37		1886	371	675	22		996	605	1014	75		2089	2659	5384	209		8898
5	613	1337	30		1746	363	617	24		950	594	1038	94		1943	2571	5247	223		8514
6	619	1278	26		1674	350	560	23		876	565	1030	51		1841	2524	5079	186		8325
7	525	1185	27		1551	320	502	24		804	540	994	52		1752	2387	4929	186		8569
8	484	1118	23		1471	298	488	19		764	519	964	45		1857	2233	5214	165		8306
9	470	1097	18		1422	259	450	12		665	531	953	40		1860	2155	4988	152		8466
1890	452	1072	16		1369	232	430	13		635	516	921	78		2099	2073	4813	130		9136
1	433	1060	14		1321	224	421	13		628	506	909	49		1953	2024	4574	164		8933
2	444	1058	16		1	230	399	9		1	494	884	44		1	2116	4498	150		1
3	383	974	21		1	224	398	8		1	501	934	27		1	1981	4285	125		1
4	383	974	9		1361	248	343	4		608	496	936	17		1717	2122	4202	89		10213
5	376	953	9		1401	234	324	1		587	476	922	17		1772	1971	4182	73		10291
6	296	861	8		1113	218	313	4		486	479	936	7		1449	1743	3582	45		8992
7	291	842	27		1437	231	306	5		504	476	958	8		1461	1667	3564	78		9578
8	289	840	19		1377	228	294	7		453	459	827	14		1178	1688	3423	80		9834
9	314	852	13		1153	226	298	5		475	427	764	18		1118	1668	3246	77		8936
1900	323	863	17		1213	240	324	3		479	414	740	...		1065	1700	3316	59		8269
1	322	872	16		1181	228	301	6		470	415	740	3		1069	1684	3287	63		8034
2	323	888	16		1251	214	299	9		710	434	761	3		1088	1628	3242	66		8603
3	318	881	16		1212	206	299	6		641	442	747	5		1075	1607	3193	66		8409
4	316	890	16		1073	198	292	4		509	429	735	9		1025	1567	3159	73		7992
5	309	838	12		987	189	282	6		405	400	728	11		1010	1479	3063	79		7858
6	301	829	20		1061	176	247	6		468	395	704	10		1021	1451	2930	35		7968

2) the number of persons employed in gutting, packing, re-packing, cleaning, or drying the fish; (3) the ait and baiting lines, boat-builders, persons making and mending nets, persons manufacturing barrel staves, ait, stave wood, and hoops.

TABLE III.

Showing, for the Firth of Clyde Districts, the Total Number of Barrels of Herrings Cured, and the Estimated Total of the Number of Barrels of Herrings which were not Cured, in the Years 1843-1857.

Year.	CAMPELTOWN.			STRANRAER AND DUMFRIES.			GREENOCK, AYE, &C.			INVERARAY.			ROTHERMAY.			GLASGOW.			TOTAL.		
	Barrels Cured.	Not Cured.	Barrels Total.	Barrels Cured.	Not Cured.	Barrels Total.	Barrels Cured.	Not Cured.	Barrels Total.	Barrels Cured.	Not Cured.	Barrels Total.	Barrels Cured.	Not Cured.	Barrels Total.	Barrels Cured.	Not Cured.	Barrels Total.	Barrels Cured.	Not Cured.	Barrels Total.
1843	3796	3311	7047	2084	2587	4671	22884½	4986	27870½	8882	31860	40542	11187	614	12801	20596	...	20596	70169½	43158	113327½
4	1284	2561	3845	2764	1874	4638	18044	2340	18384	9004	6830	15834	9809	1112	10921	14196	...	14196	53101	14717	67818
5	1179	1800	2979	3800	2050	5850	18012½	2750	20762½	8983½	7825	16808½	9563	1950	11513	14470	...	14470	56008	16375	72383
6	4600	1500	6100	4446	2827	7273	17629½	2400	20029½	10008½	10400	20409½	6184	1500	7684	15530	...	15530	58843	18627	76970
7	4001	2050	6051	2555	3100	5655	15549½	2000	17549½	7857	11000	18857	4890	1500	6390	9977	...	9977	44828½	19650	64478½
8	3083	3500	6583	3344	3100	6444	12382	2000	14382	6028	10500	16528	3228½	1500	4728½	15454	...	15454	43519½	20600	64119½
9	5308	1800	6608	3208	2900	5503	22505½	3000	25505½	15609½	1000	16609½	9496½	1000	10496½	15957	...	15957	72034½	8600	80634½
1850	...	...	...	...	...	...	14298	3900	18198	17628	8440	21063	6047½	1500	7547½	10862½	...	10862½	48331	8940	57171
1	...	...	...	...	...	...	14502	4500	19002	32325	4500	39825	5313	1500	6813	20420	...	20420	75560	10500	86060
2	...	...	...	...	...	...	10645½	2100	12745½	12264½	2500	14754½	2217	1000	3217	15306	200	15506	40423	5800	46223
3	...	...	...	...	...	...	13794½	2850	16644½	25739	3500	27239	6054½	1500	7554½	25784½	...	25784½	69872½	7850	77722½
4	...	...	...	...	...	...	8456	1800	10256	20632½	3000	23632½	2396½	1000	3396½	12410	...	12410	43898	5800	49698
5	...	...	...	...	...	...	11139½	3976	15115½	26796½	4200	32996½	5074	1212	6286	18808	910	19718	63818	10298	74116
6	...	...	...	...	...	...	6595½	2330	8925½	35206½	4490	39696½	4373	964	5337	19075	890	19465	65250	8174	73424
7	...	...	...	...	...	...	6898	1455	8153	29153	4100	33252	5135½	1070	6205½	2354½	100	2454½	43340	6725	50065

TABLE IV.

Showing the Number of Barrels of Herrings actually Caught within the limits of the various Districts in the Firth of Clyde, irrespective of the place of landing, in the years 1863-1887.

Year.	Green- ock.	Glasgow.	Rothe- say.	Inver- aray.	Camp- beltown.	Ballan- trae.	Total.
1863	127	96½	3500½	29717½	2020	...	35461½
1864	171	...	34786½	15586	2847½	...	53391
1865	981	...	33706½	28788½	2346	1015	66837
1866	803	120	44337	32199	1823½	382	79664½
1867	...	11093	32440½	38964	2450	...	84947½
1868	35876	38800	13701	46378	1524½	...	136279½
1869	26081	12150	27721	41138	6469	...	113559
1870	5091½	236	27911	24766	6381	27	64412½
1871	3140	235	22362½	20405½	7183	...	53326
1872	256	...	13284	10258	6352	...	30150
1873	822	...	4685	7516½	18036	76	31135½
1874	844	...	3822	6434½	19087	451	30638½
1875	919	...	4362	14097	6660	9667	35705
1876	1814	...	6296	31621½	11411	6071	57213½
1877	1527	...	4070½	23348½	18443	10254	57643
1878	683	...	2002	11268½	18320	17493	49766½
1879	1816	...	8303	31409	36847½	25300	103675½
1880	2418	...	11167½	29315	44522	31292	118714½
1881	1248	...	4162	38162	23862	17390	84824
1882	3949	...	11806	85352	53241	13401	167749
1883	2314	...	3297	49055	49089	26501	130256
1884	4129½	...	4154	19648	40921	14019	82871½
1885	8813	...	3673	26379	45342	27671	111878
1886	...	...	2168	18145	42312	4760	67385
1887	...	...	2381	15808	57684	9881	85754

TABLE V.

Showing, for the Firth of Clyde Districts, the Total Quantity and Value of Herrings sold Fresh in the years 1884-1888, and the Total Quantity and Value of Herrings landed, whether sold Fresh or Cured, in the years 1889-1906.

HERRINGS SOLD FRESH.												
Year.	CAMPBELL-TOWN.		INVERARAY.		ROTHESAY.		GREENOCK.		BALLANTRAE.		TOTAL.	
	Crans	£	Crans	£	Crans	£	Crans	£	Crans	£	Crans	£
1884	5715	6771	1216	1840	2859	4075	1217	1604	5040	9743	16047	24033
5	5605	8379	908	1634	6409	8076	783	1186	3311	4751	17016	24026
6	5650	4265	683	1025	4859	6700	907	1893	2582	3621	14681	17504
7	5381	4075	617	778	9302	9917	1827	2306	2719	3418	19846	20494
8	6126	7348	842	1010	10422	10839	3185	5008	4555	3883	25130	28088
TOTAL QUANTITY OF HERRINGS LANDED.												
	Crans	£	Crans	£	Crans	£	Crans	£	Crans	£	Crans	£
1889	33975	37669	26249	41847	8289	12561	1840	4439	10366	8271	80719	104787
1890	42282½	36368	33650	43746	9885	12080	1186	2135	19316	19221	106319½	113550
1	41326	39351	51877	54472	10452	10655	2378	5541	14346	16519	120379	126538
2	45758	50357	50158	50158	3325	4665	1173	2832	5643	5976	106057	113988
3	70850	55959	40790	40517	4344½	4818	1835	2895	2056	2662	119875½	106851
4	73346	68990	37349	40119	2038	2835	540	1130	2654	3152	115927	116226
5	29412	34187	18013	24433	2440	4599	1228	3158	3537	5148	54630	71525
6	15240	16535	18406	26676	2521	3098	679	1226	2296	2804	39142	50339
7	24294	21911	59281	41310	3602	2707	713	1052	2067	2317	89937	69297
8	25893	26169	40903	39464	2426	2359	339	467	1599	1795	71160	70254
9	31898	40251	31374	40876	3968	4410	610	770	2917	2765	70767	89072
1900	40557	52375	24742	36280	2275	2801	189	349	5473	5080	73236	96885
1	31349	32942	29317	33410	1833	2120	267	413	10550	8837	73316	77722
2	38017	38868	26337	30577	26049	14457	1876	1966	8037	9019	100316	94887
3	29762	37779	21198	30087	28360	19550	435	504	2244	2320	81999	90240
4	12929	17314	7832	15768	7540	8958	271	424	1454	1512	30027	43976
5	21160	21676	4672	7525	1738	1615	4455	4934	4480	4938	36505	40688
6	11070	16565	5258	5907	13709	14216	7860	7786	15699	17400	53596	61874

TABLE VI.

Showing the Number of Crans of Herrings landed per Month in the Ballantrae District, 1863-1906.

Year.	Jan.	Feb.	March	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1863	...	...	...	...	...	382	368	75	...	...	...	...
4	...	...	...	...	...	258	506	66	12	8	47	6
5	...	...	...	...	...	87	283	596	24	...	1,715	1,695
6	1	...	...	...	...	107	571	384	6	21	1,292	7
7	86	4	...	...	...	126	304	330	...	...	96	30
8	...	...	...	...	795 <sup>a</sup>	...	...	452	215	98	212	28
9	...	...	...	...	...	425	1,225	534	51	25	5	14
1870	14	...	...	...	1,748 <sup>b</sup>	1,942	1,245	182	16	17	35	101
1	35	...	...	...	1,76 <sup>c</sup>	650	194	12	5	29	2	10
2	...	...	...	...	1,725*	61	139	295	...	10	10	...
3	...	...	...	...	2,025*	42	372	1,185	58	20	31	...
4	...	...	...	...	4,890*	165	867	1,063	1	...	...	...
5	...	...	...	...	9,197*	50	13	218	30	...	...	...
6	...	...	...	...	6,071*	166	919	552	17	19	...	...
7	...	...	...	...	10,254*	498	433	621	...	10	...	...
8	5,070	10,958	1,779	23	...	240	327	364	...	...	30	14
9	7,930	6,276	4,974	454	...	671	343	580	62	187	10	4,085
1880	5,200	6,518	19,452	...	...	199	1,439	2,583	933	25	134	970
1	2,872	9,310	11,922	...	...	...	649	622	286	...	11	178
2	1,183	6,188	1,327	125	...	127	843	268	188	168	251	116
3	3,697	1,766	17,566	...	...	399	778	491	131	21	9	143
4	2,813	8,465	3,280	6	...	509	966	805	490	79	166	416
5	744	5,755	14,094	...	...	297	1,218	766	461	18	...	227
6	184	2,224	2,352	...	...	27	193	1,145	395 <sup>d</sup>	94	206	37
7	48	754	9,074	...	...	15	431	603 <sup>d</sup>	464 <sup>d</sup>	35	153	70
8	450	2,127	6,938	...	...	90	513	1,328	404	8	149	913
9	875	8,981	759	...	...	139	477 <sup>d</sup>	623 <sup>d</sup>	146 <sup>d</sup>	...	587	1,070
1890	296	6,920	978	...	...	50	172	1,284 <sup>e</sup>	122 <sup>e</sup>	...	613	8,736
1	1,854	5,047	...	...	...	240 <sup>e</sup>	613 <sup>e</sup>	1,447	65 <sup>e</sup>	17 <sup>e</sup>	299	2,946
2	...	1,577	1,736	21 <sup>e</sup>	...	260	1,189	530	9	...	...	65
3	...	454	...	...	...	98	243	669	84	...	...	...
4	...	3	72	...	...	170	1,008	975	186	43	10	...
5	...	357	1,164	...	...	180	718	532	359	...	...	...
6	...	379	150	...	...	86	543	482	104	36	161	...
7	...	46	423	...	...	...	33	879	110	209	48	...
8	...	...	...	...	...	...	30*	865	324	90	7	...
9	...	...	...	...	...	145	1,247*	400	224 <sup>f</sup>	348 <sup>f</sup>	120	190
1900	...	449	3,664	...	...	106	...	567	280	36	43	8
1	...	5,652	3,743	...	...	110	...	497	263	121	43	...
2	2,450	3,072	1,316	...	...	145	...	325	466	106	157	...
3	530	177	25	...	...	96	51 <sup>d</sup>	340	962	14	37	...
4	92	461	322	...	...	...	108 <sup>e</sup>	122	238	78	27	...
5	...	...	...	...	...	...	2,987 <sup>f</sup>	360	379	631	122	...
6	584	183	389	75	...	...	265	553	631	260	...	2,564
												10,195

\* Winter fishing.

a (1868)—386 crans from 1st January to 11th July, and 409 crans for rest of July.

b (1870)—1635 crans from 1st February to 1st June, and 113 crans in last week of May.

c (1871)—1621 crans from 1st February to 13th May, and 139 crans for rest of May.

d (1900)—From 3rd October to 26th December.

e (1904)—From 1st October to 31st December.

f (1905)—106 crans from 1st January to 27th May, and 2881 crans from 1st October to 31st December.

TABLE VII.

Showing the Number of Crans of Herrings landed per Month in the Campbeltown District, 1863-1906.

Year.	Jan.	Feb.	March.	April.	May.		June.	July.	August.	Sept.	Oct.	Nov.	De
1863	...	...	...	...	...	...	210	1,674	58	54	...	...	...
4	...	...	...	...	...	...	861	1,548	358	84½	...	...	...
5	...	...	...	...	...	...	370	1,167	1,012	13	1½	...	...
6	...	...	...	...	...	...	400	671	912	37	...	...	...
7	...	...	...	...	...	...	576	727	709	26	...	...	...
8	...	...	...	...	...	...	353	699	357	323	...	...	...
9	...	...	...	...	...	...	1,105	1,981	3,352	929	79	...	...
1870	...	...	...	...	...	...	1,713	2,712	2,802	634	524	124	...
1	...	...	...	...	...	...	1,144	1,258	1,461	910	290	...	...
2	...	...	...	...	...	...	286	4,245	4,381	4,225	2,295	...	...
3	...	...	...	...	...	...	711	6,286	4,106	3,502	1,286	...	...
4	...	...	...	...	...	...	1,258	5,263	3,719	3,076	1,467	617	...
5	...	...	...	...	...	...	495	1,117	1,086	365	2	...	...
6	...	...	...	...	...	...	733	1,689	3,760	1,073	20	...	...
7	...	...	...	...	...	...	1,168	3,617	6,136	1,118	42	...	...
8	...	...	...	...	...	800a	2,127	3,861	2,005	292	...	...	...
9	...	...	...	...	...	3,476b	1,127	5,131	3,781	4,172	8,646	7,526	121
1880	...	...	...	...	...	...	5,120c	2,330	12,073	5,426	2,579	2,584	4,781
1	...	...	...	...	...	...	1,280†	3,378	6,599	3,967	1,048	440	2,638
2	...	...	...	...	...	...	2,249†	7,329	12,415	10,357	5,339	5,920	...
3	...	...	...	...	...	...	1,859†	3,267	5,980	7,695	3,312	7,122	5,751
4	...	...	...	...	...	...	1,766†	2,363	8,672	5,799	925	9,654	4,393
5	...	...	...	...	...	...	2,363†	2,528	7,839	6,279	8,922	8,911	...
6	...	...	...	...	...	...	4,607†	2,075	2,684	4,319	2,684	2,045	3,114
7	...	...	...	...	...	...	6,210†	1,263	4,470½	3,330½	10,173	3,306	10,669
8	...	...	...	...	...	...	10,890†	794	4,690	6,349	2,279½	4,702½	5,012
9	...	...	...	...	...	...	7,534†	1,569	3,120½	2,620½	2,392	5,572	8,162
1890	...	...	...	...	...	...	12,499†	1,157	3,527	156½	12	2,943½	5,053
1	...	...	...	...	...	...	12,845†	4,119	9,976	2,408½	146	1,244½	259
2	...	...	...	...	...	...	2,193½	2,817	9,156	2,005½	37½	1,594	184
3	...	...	...	...	...	...	3,601e	2,511	5,782	2,067	...	3	177
4	...	...	...	...	...	...	5,050†	7,844	3,967½	4,903½	2,017½	543	4
5	...	...	...	...	...	...	7,115½†	1,596	4,514½	2,076½	40	125	118
6	...	...	...	...	...	...	2,914†	2,177	3,380	2,104	1,109	2,457	460
7	...	...	...	...	...	...	393†	788	9,692	3,621	5,001	3,706	937
8	...	...	...	...	...	...	816†	6,421	4,937	1,780	2,771	387	2,116
9	...	...	...	...	...	...	4,120†	4,259	6,049	6,939	6,135	1,488	2,717
1900	...	...	...	...	...	...	3,994†	4,297	6,962	11,355	8,896	4,101	610
1	...	...	...	...	...	...	6,097†	3,721	6,261	7,648	3,241	894	1,081
2	...	...	...	...	...	...	3,881†	4,895	11,980	11,727	4,071	317	30
3	...	...	...	...	...	...	4,430†	3,180	9,088	9,797	694	...	272
4	...	...	...	...	...	...	5,872†	1,550	1,938	1,772	869	218	2
5	...	...	...	...	...	...	5,384†	2,886	7,737	5,175	6	32	138
6	...	...	...	...	...	...	3,562†	3,392	3,486	541	79	5	...

† From 1st January to end of May.

a (1878)—April and May.

b (1879)—3200 crans from 1st January to 24th May, and 276 crans from 24th to 31st May.

c (1880)—5090 crans from 1st January to 22nd May, and 30 crans from 22nd to 29th May.

d (1893)—From 1st January to 15th March.

e (1894)—From 1st January to end of March.

(1906)—3552 crans from 1st January to end of May, and 10 added at end of year.



TABLE VIII.

Showing the Number of Crans of Herrings landed per Month in the Inveraray District, 1854-1906.

Year.	Jan.	Feb.	March.	April.	May.		June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1854	...	...	...	...	...	...	...	5,000	6,200	800	2,400	2,200	...
5	...	...	...	...	...	3,629 <sup>a</sup>	...	5,721	10,650	2,000	3,980	4,324	869
6	...	...	...	...	...	2,418 <sup>b</sup>	...	10,782	11,300	8,200	6,500	2,750	660
7	...	...	...	...	...	2,600 <sup>c</sup>	...	8,800	5,600	2,600	3,800	1,200	...
8	...	...	...	...	...	3,000 <sup>d</sup>	...	4,600	5,050	5,450	3,000	2,450	2,400
9	...	...	...	...	...	4,045 <sup>e</sup>	...	6,055	2,750	2,780	1,744	4,569	8,452
1860	780	724	1,755	388	267	...	1,056	3,226	4,630	4,870	5,120	10,460	7,490
1	...	...	...	...	...	...	402	2,905	5,323	3,702	2,335	380	1,804
2	...	...	...	...	...	...	207	2,962	9,685	11,725	14,920	13,119	4,743
3	...	...	...	...	...	...	165	2,453	5,952	3,637	6,197	3,170	1,349
4	...	...	...	...	...	...	849	2,414	2,667	3,274	2,268	1,415	30
5	...	...	...	...	...	...	149	2,321	12,406	7,881	2,142	884	335
6	...	...	...	...	...	...	455	1,673	7,850	5,302	9,747	2,558	775
7	427	...	...	...	...	...	771	3,273	13,466	6,301	3,856	3,891	2,440
8	3,030	...	...	...	...	...	3,040	9,406	7,385	9,504	6,121	180	1,130
9	769	...	...	...	...	...	3,545	6,479	9,284	8,587	3,700	280	1,420
1870	925	...	...	...	...	...	3,580	5,972	5,170	3,089	3,703	3,675	795
1	1,840	...	...	...	...	...	3,415	2,552	2,400	717	2,082	469	40
2	...	...	...	...	...	...	715	1,550	1,932	1,261	499	2,230	820
3	...	...	...	...	...	...	1,045	1,807	134	238	424	...	...
4	...	...	...	...	...	...	715	1,366	917	1,302	490	17	...
5	10	...	...	...	...	...	650	5,675	4,069	425	1,202	1,215	300
6	30	...	...	...	...	...	1,175	4,720	4,177	1,986	7,245	3,503	...
7	...	...	...	...	...	...	2,614	4,118	5,430	4,369	2,217	870	...
8	...	...	...	...	...	...	1,344	3,885	1,271	96	24	2,140	130
9	...	...	...	...	...	...	2,168	5,744	7,409	2,805	2,396	523	...
1880	...	...	...	...	...	...	1,817	7,518	3,922	2,439	1,420	4,570	1,082
1	...	...	...	...	...	...	4,932	5,893	9,546	5,179	2,248	3,790	1,355
2	...	...	...	...	...	...	3,585	7,660	11,878	8,320	12,663	11,424	24
3	...	...	...	...	...	...	3,304	8,465	7,637	11,005	3,166	2,520	12
4	...	...	...	...	...	...	5,154	3,275	5,004	1,717	606	...	...
5	...	...	...	...	...	...	7,187	7,244	5,522	4,047	4,847	...	...
6	...	...	...	...	...	...	2,921	4,592	4,947	2,021	262	176	148
7	...	...	...	...	1,032	...	3,577	3,222	2,676	2,852 <sup>f</sup>	781	198	22
8	...	...	...	...	...	...	1,111	7,147	8,640	1,919	1,092	349	...
9	...	...	...	...	...	...	1,830	6,364	5,267	3,843 <sup>f</sup>	10,125	2,436	...
1890	...	...	...	...	...	...	1,936	12,303	8,254	3,809 <sup>f</sup>	3,285	3,463	5,241
1	...	...	...	...	...	...	2,159	10,283	3,783 <sup>f</sup>	3,639 <sup>f</sup>	9,338	11,038	7,937
2	...	...	...	...	...	...	4,509	9,206	11,129	8,406 <sup>f</sup>	3,641	3,377	7,140
3	...	...	...	...	...	...	3,251	10,802 <sup>f</sup>	10,075 <sup>f</sup>	2,700 <sup>f</sup>	705	4,416	4,439
4	...	...	...	...	...	...	3,049	10,927	9,320	3,024	1,041	3,100	7,451
5	...	...	...	...	...	1,090 <sup>*</sup>	2,117	4,271	5,508	1,674	155	1,800	1,238
6	...	...	...	...	...	2,012 <sup>*</sup>	1,444	3,874	3,591	2,314	2,405	2,442	824
7	...	...	...	...	...	849 <sup>*</sup>	1,756	5,876	10,797	19,900	6,316	5,763	5,563
8	...	...	...	...	...	736 <sup>*</sup>	4,252	11,636	8,895	5,700	3,481	3,777	2,324
9	...	...	...	...	...	...	3,013	8,552	9,573	2,899	1,691	3,798	2,687
1900	...	...	...	...	...	...	137 <sup>*</sup>	3,623	7,523	5,328	3,498	1,536	1,432
1	...	...	...	...	...	100 <sup>f</sup>	2,936	5,968	8,490	7,177	1,365	743	2,116
2	...	...	...	...	...	...	851	6,373	5,652	4,201	4,059	2,513	2,690
3	...	...	...	...	...	12 <sup>*</sup>	865	9,303	2,477	6,511	1,277	111	642
4	...	...	...	...	252	69 <sup>†</sup>	1,808	3,012	1,884	565	13	...	224
5	...	...	...	...	970	558 <sup>†</sup>	512	440	327	210	328	419	908
6	...	...	...	...	522	234 <sup>†</sup>	706	1,022	286	699	1,484	255	50

\* From 1st January to end of May.

† From 1st January to end of April.

a 1326 crans from 1st January to 9th June, and 2303 crans from 9th to 30th June.

b 1178 crans from 1st January to 14th June, and 1240 crans from 14th to 28th June.

c 1716 crans from 1st January to 13th June, and 884 crans from 13th to 27th June.

d From 1st January to end of June.

e 3209 crans from 1st January to 11th June, and 836 crans from 11th June to 2nd July.

f 100 crans from 1st January to 18th May, and 222 crans from 18th to end of May.

TABLE IX.

Showing the Number of Crans of Herrings landed per Month in the Districts of Inveraray and Campbeltown, 1854-1906.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	T
1854	...	...	...	...	...	...	5,000	6,200	800	2,400	2,200	...	10
5	...	...	...	...	...	...	5,721	10,650	2,000	3,980	4,324	869	3
6	...	...	...	...	...	...	10,782	11,300	8,200	6,500	2,750	660	4
7	...	...	...	...	...	...	8,800	5,600	2,600	3,800	1,200	...	2
8	...	...	...	...	...	...	4,600	5,050	5,450	3,000	2,450	2,400	2
9	...	...	...	...	...	...	6,055	2,750	2,780	1,744	4,569	8,452	3
1860	780	724	1,755	338	267	1,056	3,226	4,630	4,870	5,120	10,460	7,490	40
1	...	...	...	...	...	402	2,905	5,323	3,702	2,335	380	1,804	10
2	...	...	...	...	...	207	2,962	9,685	11,725	14,920	13,119	4,743	5
3	...	...	...	...	...	376	4,127	6,010	3,642	6,197	3,170	1,349	24
4	...	...	...	...	...	1,710	3,962	3,025	3,308	2,268	1,415	30	15
5	...	...	...	...	...	345	3,662	13,418	7,894	2,143	884	335	28
6	...	...	...	...	...	855	2,344	8,762	5,339	9,747	2,558	775	30
7	427	...	...	...	...	1,347	4,000	14,165	6,327	3,856	3,891	2,440	30
8	3,030	...	...	...	...	3,393	10,104	7,742	9,827	6,121	180	1,130	40
9	769	...	...	...	...	4,650	8,460	12,616	9,516	3,779	260	1,420	41
1870	925	...	...	...	...	5,293	8,684	7,972	3,723	4,227	3,799	795	30
1	1,840	...	...	...	...	4,559	3,810	3,861	1,627	2,372	469	40	15
2	...	...	...	...	...	1,001	5,795	6,363	5,486	2,794	2,230	820	24
3	...	...	...	...	...	1,756	8,093	4,240	3,740	1,710	...	...	15
4	...	...	...	...	...	1,973	6,628	4,636	4,378	1,957	634	...	20
5	...	...	...	...	...	1,145	6,792	5,155	790	1,204	1,215	309	16
6	...	...	...	...	...	1,908	6,409	7,937	3,059	7,265	3,503	...	30
7	...	...	...	...	...	3,782	7,735	11,566	5,487	2,259	870	...	31
8	...	...	...	...	...	3,471	7,746	3,276	388	24	2,140	130	17
9	...	...	...	...	...	3,295	10,875	11,190	6,977	11,042	8,049	121	52
1880	...	...	...	...	...	4,147	19,591	9,348	5,018	4,004	7,195	5,865	60
1	...	...	...	...	...	5,864	14,938	13,513	6,227	2,688	4,833	3,993	55
2	...	...	...	...	...	6,115	25,074	22,235	13,659	18,583	11,424	24	90
3	...	...	...	...	...	6,571	14,445	15,332	10,670	13,935	8,271	1,491	7
4	...	...	...	...	...	6,431	9,732	14,104	2,642	10,260	4,393	...	46
5	...	...	...	...	...	9,715	15,083	11,801	12,969	13,758	...	...	63
6	...	...	...	...	...	4,996	7,276	9,266	4,705	2,307	3,290	7,933	44
7	...	...	...	...	...	4,840	7,692	6,006	13,025	4,087	10,867	4,135	57
8	...	...	...	...	...	1,815	11,837	14,989	4,198	5,794	5,361	6,742	6
9	...	...	...	...	...	3,399	9,484	7,887	6,235	15,697	10,598	1,936	65
1890	...	...	...	...	...	3,093	15,830	8,410	3,821	6,228	8,516	5,346	65
1	...	...	...	...	...	6,278	20,259	6,192	3,785	10,632	11,297	7,937	73
2	...	...	...	...	...	7,326	18,362	13,134	8,443	5,235	3,561	7,317	64
3	...	...	...	...	...	5,762	16,584	12,142	2,700	708	4,416	4,616	54
4	...	...	...	...	...	10,893	14,794	14,223	5,041	1,584	3,104	7,451	6
5	...	...	...	...	...	3,713	8,785	7,584	1,714	280	1,918	1,418	30
6	...	...	...	...	...	3,621	7,254	5,695	3,423	4,862	2,902	696	3
7	...	...	...	...	...	2,544	15,568	14,418	24,901	10,022	6,700	5,627	8
8	...	...	...	...	...	10,673	16,573	10,675	8,471	3,868	5,893	6,913	6
9	...	...	...	...	...	7,272	14,601	16,512	9,034	3,179	6,515	2,778	6
1900	...	...	...	...	...	7,547	14,485	16,678	12,394	5,637	2,281	1,774	60
1	...	...	...	...	...	6,657	12,229	16,138	10,418	2,259	1,824	4,522	60
2	...	...	...	...	...	5,746	18,353	17,379	8,272	4,376	2,543	3,805	6
3	...	...	...	...	...	4,045	18,391	12,274	7,205	1,277	383	2,943	54
4	...	...	...	...	...	3,358	4,950	3,656	1,434	231	2	909	24
5	...	...	...	...	...	3,398	8,177	5,502	216	360	557	1,008	24
6	...	...	...	...	...	4,098	4,508	827	778	1,489	255	55	10

\* Including other quantities referred to in Tables

TABLE X.

Year.	Jan.	Feb.	March.	April.	May.		June.	July	August.	Sept.	Oct.	Nov.	Dec.
1855	...	...	...	...	...	1,804a	...	1,630	166	...	...	...	...
6	...	...	...	...	...	290b	...	210	10	...	...	...	...
7	...	...	...	...	...	190c	...	540	60	10	...	...	...
8	...	...	...	...	...	90d	...	1,887	108	...	...	...	...
9	...	...	...	...	...	650e	...	950	50	...	...	...	...
1860	...	...	...	...	...	220f	...	500	1,650	530	50	...	...
1	...	...	...	...	...	95g	...	535	95	...	...	...	...
2	...	...	...	...	...	70h	...	896	2,564	1,675	55	...	...
3	...	...	...	...	...	129i	...	456	122	13	1/2	...	...
4	...	...	...	...	...	...	113	482	251	38	57	328	4
5	...	...	...	...	...	...	24	249	1,200	232	113	2,322	855
6	437	...	...	...	...	...	38	580	506	37	132	927	67
7	309	...	...	...	...	...	28	178	403	98	68	118	66
8	...	...	...	...	...	20*	...	576	401	428	3,179	19,796	9,240
9	470	...	...	...	...	...	101	706	1,036	476	9,051	4,175	652
1870	300	...	...	...	...	...	552	1,146	644	318	102	240	1,048
1	40	...	...	...	...	...	414	233	143	20	22	688	700
2	...	...	...	...	...	15j	...	62	141	82	244	9	...
3	...	...	...	...	...	...	75	791	196	108	468	288	...
4	...	...	...	...	...	...	372	338	696	439	...	...	...
5	...	...	...	...	...	...	...	193	418	81	...	...	...
6	...	...	...	...	...	...	262	366	757	115	17	...	...
7	...	...	...	...	...	...	234	401	710	148	9	...	...
8	...	...	...	...	64	...	88	231	222	3	...	...	...
9	...	...	...	...	...	98*	...	606	501	301	74	...	...
1880	...	...	...	...	...	260*	...	1,389	411	57	...	...	...
1	...	...	...	...	...	132*	...	432	463	187	...	...	...
2	...	...	...	...	...	284*	...	671	1,592	1,165	22	...	...
3	...	...	...	...	...	149*	...	453	531	386	...	...	...
4	...	...	...	...	...	...	164	789	898	166	...	...	...
5	...	...	...	...	...	...	318	557	391	95	...	...	...
6	...	...	...	...	...	...	15	850	310	121	...	...	...
7	...	...	...	...	...	...	36	5151	835	2491	...	...	...
8	...	...	...	...	...	...	688	1,211	1,1271	441	...	...	...
9	...	...	...	...	64	...	6561	8581	476	13	...	...	...
1890	...	...	...	...	2181	...	821	591	1611	181	...	...	...
1	...	...	...	...	57	...	7921	1,1031	527	621	...	...	...
2	...	...	...	...	13	...	4671	440	1861	...	...	...	...
3	...	...	...	...	136	...	2651	9081	6841	66	...	...	...
4	...	...	...	...	81	...	1961	2421	80	...	...	...	...
5	...	...	...	...	...	...	496	3921	223	161	...	...	...
6	...	...	...	...	...	...	1461	3971	118	...	...	...	...
7	...	...	...	...	22	...	8	329	241	88	...	...	...
8	...	...	...	...	...	...	44+	23	144	75	9	...	...
9	...	...	...	...	...	200+	241	38	249	70	1	...	...
1900	...	...	...	...	...	9+	78	311	27	32	41	...	...
1	...	...	...	...	...	124+	15	127	74	20	2	...	...
2	...	...	...	...	...	377+	...	98	87	12	1,381	...	...
3	...	...	...	...	...	28*	...	256	38	10	...	...	...
4	...	...	...	...	...	168/	...	58	29	16	...	...	...
5	...	...	...	...	...	375n	...	38	317	1,533	1,971	221	...
6	...	...	...	...	...	687*	...	141	1,304	1,630	451	2,014	1,638

† " " " " " May.

a 1391 crans from 1st January to June 23rd, and 413 crans from June 23rd to 30th.

8	70	"	"	"	"	"	"	14th	"	220	"	"	"	14th	"	28th.
	15							18th	"	175	"	"	"	18th	"	27th.

c	15	,	"	"	"	"	"	13th	"	175	"	"	"	13th	"	27th.
d	7							5th		83				5th		28th

4	7	..	..	..	..	..	5th	..	83	..	..	..	8th	..	20th.
e	52	..	..	..	..	..	18th	..	598	..	..	..	18th	..	July

32	"	"	"	"	"	"	18th	"	203	"	"	"	18th	"	30th.
f 17	"	"	"	"	"	"	9th	"	203	"	"	"	9th	"	30th.

50	"	"	"	"	"	"	22nd	"	45	"	"	"	22nd	"	29th.
----	---	---	---	---	---	---	------	---	----	---	---	---	------	---	-------

4	"	"	"	"	"	"	7th	"	66	"	"	"	7th	"	28th.
10	"	"	"	"	"	"	2d	"	22	"	"	"	2d	"	27th.

From 1st June to 6th July " " 6th " 80 " " " 6th " 27th.

\* Landed in small quantities.

4 Winter 18 crans, and 150 crans landed since 1st October.

79 " " 296 " " " 11th November

TABLE XI.

Showing the Number of Crans of Herrings per Month landed in the Rothesay District, 1854-1906.

Year.	Jan.	Feb.	Mar.	April.	May.		June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1854	...	...	...	...	...	...	...	300	180	...	...	...	...
5	...	...	...	...	...	...	1,800	1,600	700	...	...	...	...
6	...	...	...	...	...	...	500	1,000	1,100	475	...	...	...
7	...	...	...	...	...	...	150	1,350	200	440	360	...	...
8	...	...	...	...	...	...	500 <sup>a</sup>	800	1,080	200	...	...	...
9	...	...	...	...	...	...	...	440	230	...	...	550	...
1860	...	...	...	...	...	...	...	240	3,070	1,990	2,200	620	850
1	...	...	...	...	...	...	10	531	460	100	1,170	410	50
2	...	...	...	...	...	...	...	255	1,595	325	...	89	20
3	...	...	...	...	...	...	8	532	340	107	231	592	2,832
4	...	...	...	...	...	...	...	1,400	560	880	4,267	12,580	16,631
5	...	...	...	...	...	...	10	690	4,542	2,758	6,950	6,986	16,500
6	...	...	...	...	...	...	...	306	2,455	579	3,098	15,699	5,780
7	...	...	...	...	...	...	...	...	400	220	5,014	3,077	7,320
8	...	...	...	...	...	...	...	120	305	560	930	228	4,634
9	...	...	...	...	...	...	406	...	937	1,565	3,430	5,580	8,825
1870	...	...	...	...	...	...	...	1,370	1,090	1,133	1,050	2,141	9,000
1	...	...	...	...	...	...	800	455	1,315	525	38	4,696	4,500
2	...	...	...	...	...	...	...	80	740	720	880	4,290	2,245
3	...	...	...	...	...	...	50	704	368	1,218	626	15	...
4	...	...	...	...	...	...	...	603	1,220	963	334	100	...
5	...	...	...	...	...	...	...	533	907	94	137	506	...
6	...	...	...	...	...	...	...	422	1,156	1,435	851	1,096	2
7	...	...	...	...	...	...	...	421	1,446	408	480	918	...
8	...	...	...	...	...	...	25	428	386	18	...	118	62
9	...	...	...	...	...	...	92	955	1,102	760	1,775	1,172	18
1880	...	...	...	...	...	...	176	3,703	1,638	248	855	1,956	253
1	...	...	...	...	...	...	...	264	832	22	...	192	68
2	...	...	...	...	...	...	350 <sup>b</sup>	789	541	170	1,551	1,651	25
3	...	...	...	...	...	...	410 <sup>c</sup>	305	286	137	343	484	42
4	...	...	...	...	...	...	552 <sup>d</sup>	826	1,293	340	874	431	245
5	...	...	...	...	...	...	1,050 <sup>e</sup>	783	378	662	3,088	558	476
6	...	...	...	...	...	...	125 <sup>f</sup>	613	603 <sup>g</sup>	123 <sup>h</sup>	1,911	570	488
7	...	...	...	...	...	...	250 <sup>i</sup>	1,920	2,965	1,681	1,650	1,240	670
8	...	...	...	...	...	...	697 <sup>j</sup>	377	2,890	4,015 <sup>k</sup>	995 <sup>l</sup>	490 <sup>m</sup>	371
9	...	...	...	...	...	...	42 <sup>n</sup>	452	1,893 <sup>o</sup>	3,468 <sup>p</sup>	1,227	1,731 <sup>q</sup>	519 <sup>r</sup>
1890	...	...	...	...	...	...	276 <sup>s</sup>	56	6,002	8,612 <sup>t</sup>	2,548 <sup>u</sup>	515 <sup>v</sup>	593
1	...	...	...	...	...	...	278 <sup>w</sup>	792	4,764 <sup>x</sup>	2,275 <sup>y</sup>	833	476	1,980
2	...	...	...	...	...	...	525 <sup>z</sup>	...	823	722 <sup>aa</sup>	434	2,224 <sup>ab</sup>	136
3	...	...	...	...	...	...	368 <sup>ac</sup>	...	1,880	996 <sup>ad</sup>	154 <sup>ae</sup>	20	133
4	...	...	...	...	...	...	364 <sup>af</sup>	...	1,089	528	80	74	8
5	...	...	...	...	...	...	100 <sup>ag</sup>	707	780	516	89	78	6
6	...	...	...	...	...	...	442 <sup>ah</sup>	...	937	548	236	253	30
7	...	...	...	...	...	...	177 <sup>ai</sup>	...	919	749	1,108	251	522
8	...	...	...	...	...	...	368 <sup>aj</sup>	...	658	478	303	99	222
9	...	...	...	...	...	...	273 <sup>ak</sup>	119	411	820	430	1,028	458
1900	...	...	...	...	...	...	287 <sup>al</sup>	106	315	475	709	81	...
1	...	...	...	...	...	...	368 <sup>am</sup>	...	506	626	280	45	...
2	...	...	...	...	...	...	183 <sup>an</sup>	262	624	560	224	2,705	12,344
3	7,131	144	...	...	...	...	285 <sup>ao</sup>	152	413	351	3,327	2,944	2,717
4	...	...	...	...	...	...	3,013 <sup>ap</sup>	38	204	366	2,574	335	48
5	...	...	...	...	...	...	430 <sup>aq</sup>	40	293	181	391	285	73
6	...	...	...	...	...	...	163 <sup>ar</sup>	133	416	2,754	6,070	3,904	72

\* From 1st January to end of June.

† From 1st January to end of May.

‡ For small creeks.

a (1858)—For January and February.

b (1882)—Up to 8th July.

c (1883)—Up to 14th July.

d (1884)—Up to 5th July.

e (1900)—104 crans up to June 16th, and 183 crans for small creeks in July.

f (1904)—Winter 2843 crans, 170 crans up to June 20th.

g (1905)—Winter 206 crans, 204 crans up to June 24th. 20 crans from small creeks.

h (1906)—Winter 57 crans, 106 crans up to June 2nd.

i (1901)—Up to end of June 338 crans, and 30 crans landed in small quantities.

Notes—97 crans are added to month of October, 1904, for small creeks for which no details are to be had.

47 Do.

do.

October, 1905,

do.

do.

do.

e (1885)—Up to 20th June.

f (1896)—Up to 3rd July.

g (1888)—Up to 23rd June.

h (1889)—Up to 22nd June.

i (1890)—Up to 14th June.

j (1891)—Up to 20th June.

k (1899)—Up to 17th June.

TABLE XII.

Showing the Number of Crans of Herrings landed per Month for the whole Clyde Area, 1854-1906.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1854	...	...	...	...	...	...	5,300	6,380	800	2,400	2,200	...	17,080
5	...	...	...	...	...	...	8,951	11,516	2,000	3,980	4,324	869	38,873
6	...	...	...	...	...	...	11,992	5,860	8,675	6,500	2,750	660	46,195
7	...	...	...	...	...	...	10,692	6,238	3,050	4,160	1,200	...	27,900
8	...	...	...	...	...	...	7,287	3,030	5,650	3,000	2,450	2,400	30,615
9	...	...	...	...	...	...	7,445	12,410	2,780	1,744	5,119	8,452	33,265
1860	...	...	...	...	...	...	3,966	9,350	7,390	7,370	11,080	8,340	52,686
1	...	...	...	...	...	...	3,971	5,878	3,802	3,505	790	1,854	20,307
2	...	...	...	...	...	...	4,113	13,844	13,725	14,975	13,208	4,763	64,905
3	...	...	...	...	...	...	5,483	6,547	3,762	6,428	3,762	4,181	31,058
4	...	...	...	...	...	2,081	6,350	3,902	4,238	6,600	14,370	16,671	54,212
5	...	...	...	...	...	466	4,884	19,756	10,908	9,206	11,907	19,385	76,512
6	7,898	...	...	...	...	1,000	3,801	12,107	5,861	12,998	20,476	6,549	70,790
7	13,562	4	...	...	...	1,501	4,480	15,298	6,645	8,938	7,182	9,856	67,466
8	...	...	...	...	...	...	...	8,900	11,030	10,328	20,416	15,082	86,679
9	4,589	...	...	...	...	5,582	10,391	15,123	11,608	16,285	10,023	10,911	84,512
1870	3,689	...	...	...	...	7,787	12,445	9,888	5,190	5,396	6,215	10,944	63,302
1	6,175	...	...	...	...	6,423	4,692	5,331	2,177	2,461	5,855	5,250	40,124
2	180	...	...	...	...	1,062	6,076	7,539	6,288	3,928	6,539	3,065	36,417
3	170	...	...	...	42	2,253	10,773	5,000	5,124	2,324	334	...	28,545
4	...	...	...	...	165	3,212	8,632	7,916	5,781	2,291	734	...	33,621
5	10	...	...	...	50	1,158	7,736	6,701	995	1,341	1,721	300	29,209
6	30	...	...	...	166	3,089	7,749	10,182	4,626	8,152	4,599	2	44,666
7	...	...	...	...	498	4,449	9,178	14,103	6,043	2,758	1,788	...	49,071
8	5,070	10,958	1,779	...	...	3,911	8,769	3,884	409	24	2,288	26	38,425
9	...	...	...	...	...	...	13,016	13,208	8,100	13,078	9,231	4,224	88,466
1880	...	...	...	...	...	...	27,266	11,730	5,348	4,993	9,898	7,088	108,834
1	...	...	...	...	...	...	16,256	15,094	6,436	2,688	5,036	4,239	81,778
2	...	...	...	...	...	...	26,802	24,556	15,162	20,407	13,237	165	119,130
3	...	...	...	...	...	...	15,694	16,280	11,214	14,278	8,764	1,676	101,101
4	...	...	...	...	...	...	12,152	16,785	3,227	11,300	5,152	661	74,229
5	...	...	...	...	...	...	17,189	13,031	13,744	16,846	558	703	97,815
6	...	...	...	...	...	...	9,384	10,575	4,935	4,424	3,888	8,457	56,387
7	...	...	...	...	...	...	10,731	10,271	14,991	5,890	12,210	4,875	81,658
8	...	...	...	...	...	...	17,266	20,535	5,246	6,434	5,732	7,738	87,537
9	...	...	...	...	...	...	12,360	11,978	7,475	17,428	11,714	3,021	87,357
1890	...	...	...	...	...	...	23,707	17,307	6,383	6,744	9,722	14,227	102,733
1	...	...	...	...	...	...	27,574	9,060	4,698	11,407	14,240	10,997	106,774
2	...	...	...	...	...	...	20,155	14,053	8,877	5,457	3,697	7,392	74,940
3	...	...	...	...	...	...	20,041	13,907	2,921	728	4,549	4,616	57,691
4	...	...	...	...	...	...	17,100	15,017	5,164	1,668	3,112	7,451	67,783
5	...	...	...	...	...	5,634	10,490	8,682	1,819	358	1,924	1,418	40,332
6	...	...	...	...	...	...	9,070	6,465	3,695	5,276	2,932	696	38,428
7	...	...	...	...	...	...	17,695	15,518	26,306	10,321	7,022	5,639	86,996
8	...	...	...	...	...	...	17,699	11,318	8,790	3,967	6,115	6,913	68,357
9	...	...	...	...	...	...	15,274	17,929	9,654	4,346	7,138	2,968	71,110
1900	...	...	...	...	...	...	15,111	17,396	13,171	5,765	2,292	1,782	72,935
1	...	...	...	...	...	7,169	13,125	16,959	10,731	2,306	1,932	4,552	73,073
2	...	...	...	...	...	6,333	19,541	18,132	8,665	8,462	14,887	12,952	100,397
3	...	...	...	...	...	4,537	20,022	12,677	10,579	4,241	3,100	13,840	81,905
4	...	...	...	...	...	3,518	5,450	4,129	4,051	566	50	1,871	29,992
5	...	...	...	...	...	3,798	8,887	6,631	2,262	2,616	851	1,053	36,802
6	...	...	...	...	...	4,496	5,618	5,516	8,738	5,844	4,905	12,085	53,601

TABLE XIII.

Showing the Number of Crans of Herrings landed Yearly at each District in Clyde Area, 1854-1906.

Year.	Ballantrae.	Campbeltown.	Inveraray.	Greenock.	Rothsay.	Total.
1854 ...	...	...	16,600	...	480	17,080
5 ...	...	...	31,173	3,600	4,100	38,873
6 ...	...	...	42,610	510	3,075	46,195
7 ...	...	...	24,600	800	2,500	27,900
8 ...	...	...	25,950	2,085	2,580	30,615
9 ...	...	...	30,395	1,650	1,220	33,265
1860 ...	...	...	40,766	2,950	8,970	52,686
1 ...	...	...	16,851	725	2,731	20,307
2 ...	...	...	57,361	5,260	2,284	64,905
3 ...	825	1,947½	22,923	720½	4,642	31,058
4 ...	903	2,851½	12,867	1,273	36,318	54,214½
5 ...	4,400	2,563½	26,118	4,995	38,436	76,512½
6 ...	2,389	2,020	28,360	2,724	35,297	70,790
7 ...	956	2,038	34,415	1,266	28,791	67,466
8 ...	1,800	1,732	39,795	33,640	9,712	86,679
9 ...	2,279	7,446	34,024	16,670	24,093	84,512
1870 ...	5,300	8,509	26,909	4,350	18,234	63,302
1 ...	2,697	5,063	13,515	2,260	16,589	40,124
2 ...	2,240	15,432	9,057	553	9,135	36,417
3 ...	3,929	15,891	3,648	1,926	3,151	28,545
4 ...	8,350	15,400	4,806	1,845	3,220	33,621
5 ...	9,729	3,065	13,546	692	2,177	29,209
6 ...	8,076	7,275	22,836	1,517	4,962	44,666
7 ...	12,197	12,081	19,618	1,502	3,673	49,071
8 ...	18,805	9,085	8,890	608	1,037	38,425
9 ...	25,987	33,980	21,045	1,580	5,874	88,466
1880 ...	37,600	37,520	22,768	2,117	8,829	108,834
1 ...	25,850	20,393	32,943	1,214	1,378	81,778
2 ...	10,956	43,609	55,754	3,734	5,077	119,130
3 ...	25,001	36,465	36,109	1,519	2,007	101,101
4 ...	18,323	33,572	15,756	2,017	4,561	74,229
5 ...	23,580	36,842	28,847	1,361	7,185	97,815
6 ...	6,885½	29,318	15,062	687½	4,434	56,387
7 ...	11,751	43,535	14,360½	1,636	10,376	81,658½
8 ...	12,920	41,369	20,258	3,071	9,919	87,537
9 ...	13,668½	32,906½	29,865½	2,068	8,849	87,357
1890 ...	19,172	25,453	38,291½	1,067½	18,749	102,733
1 ...	13,493	30,997½	48,228	2,542½	11,513	106,774½
2 ...	5,387½	18,163½	47,408½	1,107½	2,873	74,940
3 ...	1,548	14,141	36,389½	2,060½	3,552	57,691
4 ...	2,467	24,279½	38,367	527	2,143	67,783½
5 ...	3,310	15,765½	17,853	1,128	2,276	40,332½
6 ...	1,941	14,973	18,406	662	2,446	38,428
7 ...	1,748	24,202	56,820	688	3,538	86,996
8 ...	1,316	23,817	40,801	295	2,128	68,357
9 ...	2,978	31,898	32,113	582½	3,539	71,110½
1900 ...	5,480	40,557	24,743	182	1,973	72,935
1 ...	10,537	31,349	29,117	250½	1,825	73,078½
2 ...	8,037	38,016	26,339	1,955	26,049	100,397
3 ...	2,252	29,762	21,198	332	28,361	81,905
4 ...	1,448	12,906	7,827	271	7,540	29,992
5 ...	4,479	21,458	4,672	4,455	1,738	36,802
6 ...	15,699	11,070	5,258	7,865	13,709	53,601

TABLE XIV.

Showing the Number of Boats per Month Fishing in the Ballantrae District, 1863-1906.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1863	...	...	...	...	...	286	325	136	3	...	...	...	750
4	...	...	...	...	...	355	284	99	13	5	19	3	778
5	...	...	...	...	...	227	201	185	6	...	101	115	835
6	3	...	...	...	...	202	219	141	6	2	139	28	740
7	47	...	...	...	...	191	224	199	3	...	10	2	676
8	16	...	...	...	...	...	148	142	43	25	12	10	396
9	8	...	...	...	...	206	319	174	19	28	5	6	765
1870	37	...	...	...	48	332	269	88	15	13	23	5	830
1	22	...	...	...	116	420	238	23	5	8	4	1	837
2	...	...	...	...	...	247	27	157	...	4	5	...	630
3	...	...	...	...	26	231	336	99	17	5	16	...	730
4	...	...	...	...	57	267	304	109	2	...	...	...	739
5	...	...	...	...	84	164	209	142	18	...	...	...	617
6	...	...	...	...	150	354	262	158	10	17	...	...	951
7	...	...	...	...	237	263	238	113	...	2	...	...	853
8	386	692	577	15	183	327	197	...	...	...	10	21	2408
9	838	961	711	57	174	312	195	198	50	63	15	434	4008
1880	983	1004	647	10	107	447	543	193	58	70	478	301	4841
1	1200	1202	606	...	...	483	368	176	...	...	86	273	4394
2	754	1227	433	...	178	703	184	51	40	45	21	186	3822
3	856	812	555	...	322	553	341	125	41	...	2	162	3769
4	599	979	423	40	357	511	376	167	31	16	34	82	3615
5	312	1029	755	...	189	498	465	179	14	...	...	38	3479
6	201	764	764	...	24	257	501	242	57	82	36	48	2976
7	94	254	307	...	7	317	283	170	34	7	57	46	1576
8	121	137	170	...	97	285	262	171	8	43	...	146	1440
9	178	372	54	...	101	295	244	112	...	...	42	196	1594
1890	129	451	174	...	124	183	321	82	...	...	74	502	2040
1	333	665	...	...	140	301	308	64	18	24	207	315	2375
2	...	118	99	16	114	387	288	16	...	...	...	34	1072
3	6	132	5	...	110	263	169	37	...	...	...	...	722
4	...	3	40	...	100	307	294	125	22	2	...	...	893
5	...	51	119	...	141	299	270	152	...	...	...	...	1032
6	...	9	23	...	92	256	228	40	15	60	...	...	723
7	...	21	51	...	...	74	276	79	50	51	...	...	602
8	...	...	...	...	...	240	202	?	?	...	...	...	442
9	...	...	...	...	58	243	130	157	47	67	48	...	750
1900	...	77	132	...	48	185	134	87	17	30	13	6	729
1	...	336	146	...	71	160	125	62	34	...	...	...	934
2	248	407	198	...	63	107	180	77	...	...	...	...	1280
3	117	101	38	...	52	115	183	6	44	21	...	...	677
4	46	136	63	...	...	121	143	70	23	...	...	...	602
5	...	...	...	...	...	146	120	156	46	...	...	...	468
6	...	80	45	...	...	133	136	142	68	...	184	387	1175

TABLE XV.

Showing the Number of Boats per Month Fishing in the Campbeltown District,  
1863-1906.

Year.	Jan.	Feb.	Mar.	Apr.	May	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1863	...	...	...	...	...	230	586	98	23	...	...	...	937
4	...	...	...	...	...	346	415	243	69	2	...	...	1075
5	...	...	...	...	...	364	385	341	6	1	...	...	1097
6	...	...	...	...	...	358	395	324	26	...	...	...	1103
7	...	...	...	...	...	326	334	302	27	...	...	...	989
8	...	...	...	...	...	220	290	159	80	...	...	...	749
9	...	...	...	...	...	212	544	573	285	18	...	...	1632
1870	...	...	...	...	...	227	465	702	541	172	31	...	2138
1	...	...	...	...	...	324	766	1116	488	175	...	...	2869
2	...	...	...	...	...	286	948	1716	864	380	...	...	4194
3	...	...	...	...	...	179	1639	2019	933	334	...	...	5104
4	...	...	...	...	...	291	1375	1232	871	738	132	...	4639
5	...	...	...	...	...	325	555	486	219	14	...	...	1599
6	...	...	...	...	...	430	557	824	781	9	...	...	2601
7	...	...	...	...	...	351	457	545	381	61	...	...	1795
8	...	...	...	...	...	506	740	949	118	...	...	...	2313
9	...	...	...	...	94	660	912	584	643	870	1816	192	5771
1880	...	...	...	...	123	870	1257	747	997	1423	876	565	6858
1	...	...	...	...	...	1190	1249	1866	901	195	368	357	6126
2	...	...	...	...	...	1989	1792	1696	764	462	80	40	6823
3	...	...	...	...	...	1368	1422	1849	748	486	746	132	6751
4	...	...	...	...	...	1064	1866	1152	635	948	487	...	6172
5	...	...	...	...	...	941	1664	1128	915	959	39	4	5650
6	...	...	...	...	...	1021	1350	1146	790	829	866	555	6557
7	...	...	...	...	...	1070	1264	748	913	738	1654	1710	8097
8	...	...	...	...	...	641	1422	1163	835	947	800	1220	7028
9	...	...	...	...	...	527	580	268	128	645	698	705	3551
1890	...	...	...	...	...	911	1207	70	10	878	1066	428	4570
1	...	...	...	...	...	630	1030	233	50	261	117	...	2321
2	...	...	...	...	...	677	827	75	31	282	214	126	2232
3	...	...	...	...	...	927	795	92	...	2	2	22	1840
4	...	...	...	...	...	564	549	816	410	164	6	52	2561
5	...	...	...	...	...	684	953	584	18	52	37	64	2392
6	...	...	...	...	...	650	1009	636	435	231	99	48	3108
7	...	...	...	...	...	384	1053	464	558	232	136	40	2867
8	...	...	...	...	...	813	706	411	909	162	364	422	3787
9	...	...	...	...	...	608	638	803	715	199	208	100	3271
1900	...	...	...	...	...	706	556	794	770	610	474	84	3994
1	...	...	...	...	...	675	600	780	500	470	198	385	3608
2	...	...	...	...	...	710	860	860	560	180	12	134	3316
3	...	...	...	...	...	700	761	730	411	46	92	354	3094
4	...	...	...	...	...	565	550	680	700	170	24	180	2869
5	...	...	...	...	...	574	730	1030	37	100	98	58	2627
6	...	...	...	...	...	486	624	570	28	10	...	4	1722



TABLE XVI.

Showing the Number of Boats per Month Fishing in the Inveraray District,  
1854-1906.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1854	..	..	..	..	..	..	2175	2670	350	300	370	...	5865
5	..	..	..	..	..	..	1610	2520	1620	1160	1350	460	8720
6	..	..	..	..	..	..	2200	2220	2120	1280	810	290	8920
7	..	..	..	..	..	..	2315	2290	2180	2050	400	...	9235
8	..	..	..	..	..	..	2170	1890	2440	1800	1400	750	10,450
9	..	..	..	..	..	..	2166	2400	2650	1570	1350	1600	11,736
1860	320	145	225	170	123	1241	2012	2690	2150	1820	2010	711	13,617
1	..	..	..	..	..	1081	2255	2830	2260	2390	1190	1287	13,293
2	..	..	..	..	..	550	2270	2500	2730	3320	2823	1850	16,043
3	..	..	..	..	..	641	1957	2707	2715	3018	1933	821	13,792
4	..	..	..	..	..	1357	2136	1877	2508	1605	471	55	10,009
5	..	..	..	..	..	839	2060	2855	2035	1118	740	18	9685
6	..	..	..	..	..	730	1586	2480	2050	1975	1067	461	10,349
7	180	..	..	..	..	707	1573	1921	1984	1492	609	704	9170
8	580	..	..	..	..	746	1487	1573	1789	1822	169	178	8344
9	184	..	..	..	..	776	1747	1565	1855	1005	30	290	7452
1870	346	..	..	..	..	1090	1415	1522	1885	1434	1334	388	9414
1	160	..	..	..	..	1273	1638	1412	817	762	281	34	6377
2	10	..	..	..	..	661	952	1590	862	412	503	292	5282
3	..	..	..	..	..	548	1023	212	164	315	130	15	2407
4	..	..	..	..	..	455	1019	848	553	290	14	...	3179
5	6	..	..	..	..	359	991	865	578	646	457	251	4153
6	10	..	..	..	..	462	726	904	856	1125	714	70	4867
7	2	..	..	..	..	392	805	1772	1134	1068	277	94	5544
8	..	..	..	..	..	441	590	709	314	42	305	98	2499
9	..	..	..	..	..	403	783	746	626	685	116	...	3359
1880	..	..	..	..	..	405	693	735	895	473	928	438	4567
1	..	..	..	..	..	861	874	784	697	407	658	476	4757
2	..	..	..	..	..	620	1062	909	790	913	1211	56	5561
3	..	..	..	..	..	770	957	1032	801	849	763	45	5217
4	..	..	..	..	..	855	1203	820	737	771	90	...	4476
5	..	..	..	..	..	839	1162	742	636	741	110	...	4230
6	..	..	..	..	..	678	1033	781	755	675	554	55	4531
7	..	..	..	..	532	1180	995	1008	1187	752	608	90	6352
8	..	..	..	..	..	853	963	1028	619	601	600	180	4844
9	..	..	..	..	..	870	895	1012	670	875	750	...	5072
1890	..	..	..	..	..	1106	1154	987	472	1013	716	551	5999
1	..	..	..	..	..	1030	1147	853	848	1280	1170	1310	7638
2	..	..	..	..	..	1050	970	1035	1288	1069	1068	1304	7784
3	..	..	..	..	..	1152	1013	1291	1019	844	1040	721	7090
4	..	..	..	..	..	795	1004	1368	902	545	814	722	6150
5	..	..	..	..	..	807	885	1363	886	141	616	454	5152
6	..	..	..	..	..	738	1176	957	775	799	624	427	5496
7	..	..	..	..	..	667	1044	1147	1513	834	1024	827	7056
8	..	..	..	..	..	876	875	1355	1097	941	752	403	6299
9	..	..	..	..	..	702	777	1030	405	643	1150	540	5247
1900	..	..	..	..	..	875	784	940	620	610	910	470	5209
1	..	..	..	..	..	860	800	1010	870	690	540	570	5340
2	..	..	..	..	..	660	1005	750	860	720	580	720	5295
3	..	..	..	..	..	670	951	745	915	830	520	750	5381
4	..	..	..	..	345	930	780	720	710	500	220	750	4955
5	..	..	..	..	420	700	565	390	300	380	400	360	3515
6	..	..	..	..	450	440	500	320	160	442	60	12	2384

TABLE XVII.

Showing the Number of Boats per Month Fishing in the Inveraray and  
Campbeltown Districts, 1854-1906.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1854	...	...	...	...	...	...	2175	2670	350	300	370	...	5865
5	...	...	...	...	...	...	1610	2520	1620	1160	1350	460	8720
6	...	...	...	...	...	...	2200	2220	2120	1280	810	290	8920
7	...	...	...	...	...	...	2315	2290	2180	2050	400	...	9235
8	...	...	...	...	...	...	2170	1890	2440	1800	1400	750	10,450
9	...	...	...	...	...	...	2166	2400	2650	1570	1350	1600	11,736
1860	320	145	225	170	123	1241	2012	2690	2150	1820	2010	711	13,617
1	...	...	...	...	...	1081	2255	2830	2260	2390	1190	1287	13,293
2	...	...	...	...	...	550	2270	2500	2730	3320	2823	1850	16,043
3	...	...	...	...	...	871	2543	2805	2738	3018	1933	821	14,729
4	...	...	...	...	...	1703	2551	2120	2577	1607	471	55	11,084
5	...	...	...	...	...	1203	2465	3196	2041	1119	740	18	10,782
6	...	...	...	...	...	1088	1981	2804	2076	1975	1067	461	11,452
7	180	...	...	...	...	1033	1907	2223	2011	1492	609	704	10,159
8	580	...	...	...	...	966	1777	1732	1869	1822	169	178	9093
9	184	...	...	...	...	988	2291	2138	2140	1023	30	290	9084
1870	346	...	...	...	...	1317	1880	2224	2426	1606	1365	388	11,552
1	160	...	...	...	...	1597	2404	2528	1305	937	281	34	9246
2	10	...	...	...	...	947	1900	3306	1726	792	503	292	9476
3	...	...	...	...	...	727	2662	2231	1097	649	130	15	7511
4	...	...	...	...	...	746	2394	2080	1424	1028	146	...	7818
5	6	...	...	...	...	684	1546	1351	797	660	457	251	5752
6	10	...	...	...	...	892	1283	1728	1637	1134	714	70	7468
7	2	...	...	...	...	743	1262	2317	1515	1129	277	94	7339
8	...	...	...	...	...	947	1330	1658	432	42	305	98	4812
9	...	...	...	...	94	1063	1695	1330	1269	1555	1932	192	9130
1880	...	...	...	...	123	1275	1950	1482	1892	1896	1804	1003	11,425
1	...	...	...	...	...	2051	2123	2650	1598	602	1026	833	10,883
2	...	...	...	...	...	2609	2854	2605	1554	1375	1291	96	12,384
3	...	...	...	...	...	2138	2379	2881	1549	1335	1509	177	11,968
4	...	...	...	...	...	1939	3069	1972	1372	1719	577	...	10,648
5	...	...	...	...	...	1780	2826	1870	1551	1700	149	4	9880
6	...	...	...	...	...	1699	2383	1927	1545	1504	1420	610	11,088
7	...	...	...	...	532	2250	2259	1756	2100	1490	2262	1800	14,449
8	...	...	...	...	...	1494	2385	2191	1454	1548	1400	1400	11,872
9	...	...	...	...	...	1397	1475	1280	798	1520	1448	705	8623
1890	...	...	...	...	...	2017	2361	1057	482	1891	1782	979	10,569
1	...	...	...	...	...	1660	2177	1086	898	1541	1287	1310	9959
2	...	...	...	...	...	1727	1797	1110	1319	1351	1282	1430	10,016
3	...	...	...	...	...	2079	1808	1383	1019	846	1042	743	8920
4	...	...	...	...	...	1359	1553	2184	1312	709	820	774	8711
5	...	...	...	...	...	1491	1838	1947	904	193	653	518	7544
6	...	...	...	...	...	1388	2185	1593	1210	1030	723	475	8604
7	...	...	...	...	...	1051	2097	1611	2071	1066	1160	867	9923
8	...	...	...	...	...	1689	1581	1766	2006	1103	1116	825	10,086
9	...	...	...	...	...	1310	1415	1833	1120	842	1358	640	8518
1900	...	...	...	...	...	1581	1340	1734	1390	1220	1384	554	9203
1	...	...	...	...	...	1535	1400	1790	1370	1160	738	955	8948
2	...	...	...	...	...	1370	1865	1610	1420	900	592	854	8611
3	...	...	...	...	...	1370	1612	1475	1326	876	612	1114	8385
4	...	...	...	...	345	1495	1330	1400	1410	670	244	930	7824
5	...	...	...	...	420	1274	1295	1420	337	480	498	418	6142
6	...	...	...	...	450	926	1124	890	188	452	60	16	4106

TABLE XVIII.

Showing the Number of Boats per Month Fishing in the Greenock District,  
1855-1906.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1855	...	...	...	...	...	121	481	140	...	...	...	...	742
6	...	...	...	...	...	216	147	28	...	...	...	...	391
7	...	...	...	...	...	208	439	57	4	...	...	...	708
8	...	...	...	...	...	210	378	100	...	...	...	...	688
9	...	...	...	...	...	223	463	123	...	...	...	...	809
1860	...	...	...	...	...	289	499	493	196	26	...	...	1503
1	...	...	...	...	...	121	433	181	...	...	...	...	735
2	...	...	...	...	...	257	612	587	401	63	...	...	1920
3	...	...	...	...	...	134	256	136	18	6	...	...	550
4	...	...	...	...	...	76	184	182	57	15	80	30	624
5	...	...	...	...	...	84	176	265	33	16	199	139	912
6	65	...	...	...	...	106	278	283	16	18	147	81	994
7	92	...	...	...	...	90	157	198	99	26	16	23	701
8	...	...	...	...	...	...	166	127	72	228	1160	1032	2785
9	70	...	...	...	...	80	252	223	368	1234	850	201	3278
1870	30	...	...	...	...	202	236	235	212	144	60	130	1249
1	...	...	...	...	...	151	184	120	24	26	218	70	793
2	...	...	...	...	...	...	90	114	33	52	8	...	297
3	...	...	...	...	...	67	255	79	25	70	47	...	543
4	...	...	...	...	...	88	181	114	108	...	...	...	491
5	...	...	...	...	...	69	103	47	...	...	...	...	219
6	...	...	...	...	...	78	161	184	59	2	...	...	484
7	...	...	...	...	...	110	154	174	47	6	...	...	491
8	...	...	...	...	...	123	97	106	3	...	...	...	329
9	...	...	...	...	...	...	237	174	94	18	...	...	523
1880	...	...	...	...	...	70	260	145	23	...	...	...	498
1	...	...	...	...	...	...	166	121	23	...	...	...	310
2	...	...	...	...	...	99	128	182	119	8	...	...	536
3	...	...	...	...	...	34	108	97	53	...	...	...	292
4	...	...	...	...	...	50	201	152	94	...	...	...	497
5	...	...	...	...	...	88	177	161	63	...	...	...	489
6	...	...	...	...	...	...	207	169	17	...	...	...	393
7	...	...	...	...	...	24	144	202	89	...	...	...	459
8	...	...	...	...	...	131	279	235	60	...	...	...	705
9	...	...	...	...	...	284	285	198	9	...	...	...	776
1890	...	...	...	...	23	167	264	128	6	..	...	...	588
1	...	...	...	...	33	278	437	172	13	...	...	...	933
2	...	...	...	...	...	301	219	109	...	...	...	...	629
3	...	...	...	...	...	230	252	150	23	...	...	...	655
4	...	...	...	...	...	113	190	140	...	...	...	...	443
5	...	...	...	...	...	247	228	168	9	...	...	...	650
6	...	...	...	...	...	130	164	47	...	...	...	...	341
7	...	...	...	...	...	67	175	121	23	...	...	...	386
8	...	...	...	...	...	72	62	47	11	...	...	...	192
9	...	...	...	...	...	54	39	106	38	3	...	...	240
1900	...	...	...	...	...	60	35	21	9	2	...	...	127
1	...	...	...	...	...	46	48	54	10	3	...	...	161
2	...	...	...	...	...	45	49	9	270	...	...	...	373
3	...	...	...	...	...	...	45	27	7	...	...	...	79
4	...	...	...	...	...	...	42	48	29	...	...	...	119
5	...	...	...	...	...	...	24	38	157	236	110	...	565
6	...	...	...	...	...	...	36	80	62	22	291	288	779

TABLE XIX.

Showing the Number of Boats per Month Fishing in the Rothersey District  
1854-1906.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1854	...	...	...	...	...	...	202	75	...	...	...	...	277
5	...	...	...	...	...	70	324	285	...	...	...	...	679
6	...	...	...	...	...	60	290	320	150	78	...	...	898
7	...	...	...	...	...	25	284	156	260	140	...	...	865
8	...	...	...	...	...	...	380	730	510	...	...	...	1620
9	...	...	...	...	...	...	340	360	...	...	181	...	881
1860	...	...	...	...	...	...	270	1095	950	840	442	230	3827
1	...	...	...	...	...	63	530	510	50	930	500	60	2643
2	...	...	...	...	...	...	222	414	139	...	10	4	789
3	...	...	...	...	...	17	272	202	101	278	325	625	1820
4	...	...	...	...	...	...	598	731	395	663	1340	1490	5217
5	...	...	...	...	...	14	430	1138	1195	1570	1590	1900	7837
6	780	...	...	...	...	...	260	569	200	604	2100	1360	5873
7	710	...	...	...	...	...	...	292	143	825	413	700	3083
8	418	...	...	...	...	...	63	107	129	395	12	492	1616
9	768	...	...	...	...	178	...	160	448	790	1193	1700	5237
1870	800	...	...	...	...	...	225	384	710	490	715	1360	4684
1	660	...	...	...	...	136	281	932	550	86	848	1070	4563
2	550	...	...	...	...	...	95	625	530	1095	1275	900	5070
3	270	...	...	...	...	90	460	321	422	269	50	...	1882
4	...	...	...	...	...	...	289	541	396	222	40	...	1488
5	...	...	...	...	...	...	424	264	120	141	146	...	1095
6	...	...	...	...	...	...	241	372	512	223	393	5	1746
7	...	...	...	...	...	18	210	400	168	151	127	...	1074
8	...	...	...	...	...	...	209	336	43	...	43	8	639
9	...	...	...	...	...	65	446	387	167	422	468	37	1992
1880	...	...	...	...	...	75	709	484	248	268	527	138	2449
1	...	...	...	...	...	...	197	257	15	...	43	28	540
2	...	...	...	...	...	...	384	197	72	341	538	18	1550
3	...	...	...	...	...	...	176	130	34	158	276	65	839
4	...	...	...	...	...	...	406	360	186	428	275	44	1699
5	...	...	...	...	...	140	497	212	342	645	285	151	2272
6	...	...	...	...	...	...	369	320	107	859	435	180	2270
7	...	...	...	...	...	...	500	849	343	630	400	132	2854
8	...	...	...	...	...	105	453	661	284	232	119	40	1894
9	...	...	...	...	...	125	435	619	387	574	160	20	2320
1890	...	...	...	...	...	42	652	595	325	258	154	75	2101
1	...	...	...	...	...	110	507	335	196	171	218	55	1592
2	...	...	...	...	...	224	399	255	139	107	75	20	1219
3	...	...	...	...	...	323	295	200	91	54	54	...	1017
4	...	...	...	...	...	105	240	171	37	62	24	5	644
5	...	...	...	...	...	274	374	307	94	36	12	...	1097
6	...	...	...	...	...	75	276	119	59	81	18	...	628
7	...	...	...	...	...	50	264	168	176	104	50	6	818
8	...	...	...	...	...	105	162	162	122	59	64	...	674
9	...	...	...	...	...	78	110	129	81	83	85	...	566
1900	...	...	...	...	...	47	105	106	101	26	...	...	385
1	...	...	...	...	...	11	94	107	66	14	...	...	292
2	...	...	...	...	...	18	110	136	54	349	593	637	1897
3	442	40	...	...	...	9	107	72	400	442	513	558	2583
4	...	...	...	...	...	7	73	80	509	198	46	399	1312
5	...	...	...	...	...	10	59	160	7	31	16	13	296
6	...	...	...	...	...	22	77	560	837	1003	19	41	2559

TABLE XX.

Showing the Number of Boats Fishing per Month in the whole Clyde Area,  
1854-1906.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1854	...	...	...	...	...	...	2377	2745	350	300	370	...	6142
5	...	...	...	...	...	191	2415	2945	1620	1160	1350	460	10,141
6	...	...	...	...	...	276	2637	2568	2270	1358	810	290	10,209
7	...	...	...	...	...	233	3038	2503	2444	2190	400	...	10,808
8	...	...	...	...	...	210	2928	2720	2950	1800	1400	750	12,758
9	...	...	...	...	...	223	2969	2883	2650	1570	1531	1600	13,426
1860	320	145	225	170	123	1530	2781	4278	3296	2686	2452	941	18,947
1	...	...	...	...	...	1265	3218	3521	2310	3320	1690	1347	16,671
2	...	...	...	...	...	807	3104	3501	3270	3383	2833	1854	18,752
3	...	...	...	...	...	1308	3396	3279	2860	3302	2258	1446	17,849
4	...	...	...	...	...	2134	3617	3132	3042	2290	1910	1578	17,703
5	...	...	...	...	...	1528	3272	4784	3275	2705	2630	2172	20,366
6	848	...	...	...	...	396	2738	3797	2298	2599	3453	1930	19,059
7	1029	...	...	...	...	1314	2288	2912	2256	2343	1048	1429	14,619
8	1014	...	...	...	...	966	2154	2108	2113	2470	1353	1712	13,890
9	1030	...	...	...	...	1452	2862	2695	2975	3075	2078	2197	18,364
1870	1213	...	...	...	48	1851	2610	2931	3363	2253	2163	1883	18,315
1	842	...	...	...	116	2304	3107	3603	1884	1057	1351	1175	15,439
2	560	...	...	...	...	1194	2302	4202	2289	1943	1791	1192	15,473
3	270	...	...	...	26	1115	3713	2730	1561	993	243	15	10,666
4	...	...	...	...	57	1101	3168	2844	1930	1250	186	...	10,536
5	6	...	...	...	84	917	2282	1804	935	801	603	251	7683
6	10	...	...	...	150	1324	1947	2442	2218	1376	1107	75	10,649
7	2	...	...	...	237	1134	1864	3004	1730	1288	404	94	9757
8	386	692	577	15	183	1397	1833	2100	478	42	358	127	8188
9	838	961	711	57	268	1440	2573	2089	1580	2058	2415	663	15,653
1880	983	1004	647	10	230	1867	3462	2304	2221	2234	2809	1442	19,213
1	1200	1202	606	...	...	2534	2854	3204	1636	602	1155	1134	16,127
2	754	1227	433	...	178	3411	3550	3035	1785	1769	1850	300	18,292
3	856	812	555	...	322	2725	3004	3233	1677	1493	1787	404	16,868
4	599	979	423	40	357	2500	4052	2651	1683	2163	866	126	16,459
5	312	1029	755	...	189	2506	3965	2422	1970	2345	434	193	16,120
6	201	764	764	...	24	1956	3460	2658	1726	2445	1891	838	16,727
7	94	254	307	...	539	2591	3186	2977	2566	2127	2719	1978	19,338
8	121	137	170	...	97	2015	3379	3258	1806	1823	1519	1586	15,911
9	178	372	54	...	101	2101	2439	2209	1194	2094	1650	921	13,313
1890	129	451	174	...	147	2409	3598	1862	813	2149	2010	1556	15,298
1	333	665	...	...	173	2349	3429	1657	1125	1736	1712	1680	14,859
2	...	118	99	16	114	2639	2703	1490	1458	1458	1357	1484	12,936
3	6	132	5	...	110	2895	2524	1770	1133	900	1096	743	11,314
4	...	3	40	...	100	1884	2277	2620	1371	773	844	779	10,691
5	...	51	119	...	141	2311	2710	2572	1007	229	665	518	10,323
6	...	9	23	...	92	1849	2853	1799	1284	1171	741	475	10,296
7	...	21	51	...	...	1242	2812	1979	2320	1221	1210	873	11,729
8	...	...	...	...	...	2106	2007	1975	2139	1162	1180	825	11,394
9	...	...	...	...	58	1685	1694	2225	1286	995	1491	640	10,074
1900	...	77	132	...	48	1873	1614	1948	1517	1278	1397	560	10,444
1	...	336	146	...	71	1752	1667	2013	1480	1177	738	955	10,335
2	248	407	198	...	63	1540	2204	1832	1744	1249	1185	1491	12,161
3	559	141	38	...	52	1494	2047	1580	1777	1339	1125	1662	11,814
4	46	136	63	...	345	1623	1588	1598	1971	868	290	1329	9857
5	...	...	...	...	420	1430	1498	1774	547	747	624	431	7471
6	...	80	45	...	450	1061	1373	1672	1155	1477	554	732	8619

TABLE XXI.

Yearly Table of Boats Fishing in the whole Clyde Area, 1854-1906.

Year.	Ballantrae.	Campbelltown.	Inveraray.	Greenock.	Rothersey.	Total.
1854 ...	...	...	5,865	...	277	6,142
5 ...	...	...	8,720	742	679	10,141
6 ...	...	...	8,920	391	898	10,209
7 ...	...	...	9,235	708	865	10,808
8 ...	...	...	10,450	688	1,620	12,758
9 ...	...	...	11,736	809	881	13,426
1860 ...	...	...	13,617	1,503	3,827	18,947
1 ...	...	...	13,293	735	2,643	16,671
2 ...	...	...	16,043	1,920	789	18,752
3 ...	750	937	13,792	550	1,820	17,849
4 ...	778	1,075	10,009	624	5,217	17,703
5 ...	835	1,097	9,685	912	7,837	20,366
6 ...	740	1,103	10,349	994	5,873	19,059
7 ...	676	989	9,170	701	3,083	14,619
8 ...	396	749	8,344	2,785	1,616	13,890
9 ...	765	1,632	7,452	3,278	5,237	18,364
1870 ...	830	2,138	9,414	1,249	4,684	18,315
1 ...	837	2,869	6,377	793	4,563	15,439
2 ...	630	4,194	5,282	297	5,070	15,473
3 ...	730	5,104	2,407	543	1,882	10,666
4 ...	739	4,639	3,179	491	1,488	10,536
5 ...	617	1,599	4,153	219	1,095	7,683
6 ...	951	2,601	4,867	484	1,746	10,649
7 ...	853	1,795	5,544	491	1,074	9,757
8 ...	2,408	2,313	2,499	329	639	8,188
9 ...	4,008	5,771	3,359	523	1,992	15,653
1880 ...	4,841	6,858	4,567	498	2,449	19,213
1 ...	4,394	6,126	4,757	310	540	16,127
2 ...	3,822	6,823	5,561	536	1,550	18,292
3 ...	3,769	6,751	5,217	292	839	16,868
4 ...	3,615	6,172	4,476	497	1,699	16,459
5 ...	3,479	5,650	4,230	489	2,272	16,120
6 ...	2,976	6,557	4,531	393	2,270	16,727
7 ...	1,576	8,097	6,352	459	2,854	19,338
8 ...	1,440	7,028	4,844	705	1,894	15,911
9 ...	1,594	3,551	5,072	776	2,320	13,313
1890 ...	2,040	4,570	5,999	588	2,101	15,298
1 ...	2,375	2,321	7,638	933	1,592	14,859
2 ...	1,072	2,232	7,784	629	1,219	12,936
3 ...	722	1,840	7,080	655	1,017	11,314
4 ...	893	2,561	6,150	443	644	10,691
5 ...	1,032	2,392	5,152	650	1,097	10,323
6 ...	723	3,108	5,496	341	628	10,296
7 ...	602	2,867	7,056	386	818	11,729
8 ...	442	3,787	6,299	192	674	11,394
9 ...	750	3,271	5,247	240	566	10,074
1900 ...	729	3,994	5,209	127	385	10,444
1 ...	934	3,608	5,340	161	292	10,335
2 ...	1,280	3,316	5,295	373	1,897	12,161
3 ...	677	3,094	5,381	79	2,583	11,814
4 ...	602	2,869	4,955	119	1,312	9,857
5 ...	468	2,627	3,515	565	296	7,471
6 ...	1,175	1,722	2,384	779	2,559	8,619

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1854.													
July	1	.	.	.	.	400	800	.	.	.	.	400	800
"	8	.	.	.	.	450	700	.	.	.	.	450	700
"	15	.	.	.	.	460	1000	.	.	12	15	472	1015
"	22	.	.	.	.	465	1000	.	.	100	135	565	1135
"	29	.	.	.	.	400	1500	.	.	90	150	490	1650
Aug.	5	.	.	.	.	500	700	.	.	50	20	550	720
"	12	.	.	.	.	550	800	.	.	20	80	570	880
"	19	.	.	.	.	540	1500	.	.	5	50	545	1550
"	26	.	.	.	.	540	2000	.	.	?	20	540	2020
Sept.	2	.	.	.	.	540	1200	.	.	?	10	540	1210
"	9	.	.	.	.	350	800	.	.	.	.	350	800
"	16	.	.	.	.	.	.	.	.	.	.	.	.
"	23	.	.	.	.	.	.	.	.	.	.	.	.
"	30	.	.	.	.	.	.	.	.	.	.	.	.
Oct.	7	.	.	.	.	.	.	.	.	.	.	.	.
"	14	.	.	.	.	.	.	.	.	.	.	.	.
"	21	.	.	.	.	.	.	.	.	.	.	.	.
"	28	.	.	.	.	300	2400	.	.	.	.	300	2400
Nov.	4	.	.	.	.	.	.	.	.	.	.	.	.
"	11	.	.	.	.	150	500	.	.	.	.	150	500
"	18	.	.	.	.	.	.	.	.	.	.	.	.
"	25	.	.	.	.	140	1100	.	.	.	.	140	1100
Dec.	2	.	.	.	.	80	600	.	.	.	.	80	600
1855.													
To June	16	.	.	.	.	?	1326	.	.	.	.	.	.
June	23	.	.	.	.	340	830	?	1391*	.	.	340	830
"	30	.	.	.	.	390	1473	121	413	70	1800	581	3686
July	7	.	.	.	.	425	2065	121	808	90	600	636	3473
"	14	.	.	.	.	380	1674	120	445	90	600	590	2719
"	21	.	.	.	.	380	1275	120	307	90	300	590	1882
"	28	.	.	.	.	425	707	120	70	54	100	599	877
Aug.	4	.	.	.	.	480	1650	70	36	50	80	600	1766
"	11	.	.	.	.	500	2000	40	50	45	110	585	2160
"	18	.	.	.	.	500	3000	30	80	70	210	600	3290
"	25	.	.	.	.	520	1800	.	.	70	200	590	2000
Sept.	1	.	.	.	.	520	2200	.	.	50	100	570	2300
"	8	.	.	.	.	520	1000	.	.	.	.	520	1000
"	15	.	.	.	.	400	200	.	.	.	.	400	200
"	22	.	.	.	.	300	200	.	.	.	.	300	200
"	29	.	.	.	.	400	600	.	.	.	.	400	600

\* Up to June 23rd.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans.
1855.												
Oct. 6 . . . . .					300	500					300	500
" 13 . . . . .					300	600					300	600
" 20 . . . . .					300	2500					300	2500
" 27 . . . . .					260	380					260	380
Nov. 3 . . . . .					280	500					280	500
" 10 . . . . .					320	1544					320	1544
" 17 . . . . .					300	1700					300	1700
" 24 . . . . .					220	150					220	150
Dec. 1 . . . . .					230	430					230	430
" 8 . . . . .					200	250					200	250
" 15 . . . . .					180	295					180	295
" 22 . . . . .												
" 29 . . . . .					80	324					80	324
1856.												
1 Jan.—14 June . . . . .					?	1178	?	70				
June 21 . . . . .					280	590	111	117			391	707
" 28 . . . . .					320	650	105	103	60	500	485	1253
July 5 . . . . .					400	1466	69	60	60	100	520	1626
" 12 . . . . .					420	2106	27	40	35	50	482	2196
" 19 . . . . .					420	1500	20	20	40	60	480	1580
" 26 . . . . .					460	2710	20	50	70	350	550	3110
Aug. 2 . . . . .					500	3000	20	40	85	440	605	3480
" 9 . . . . .					500	3500	18	10	85	350	603	3860
" 16 . . . . .					560	3300	10		85	400	655	3700
" 23 . . . . .					580	3000			80	250	660	3250
" 30 . . . . .					580	1500			70	100	650	1600
Sept. 6 . . . . .					570	2200			55	100	625	2300
" 13 . . . . .					570	3000			30	60	600	3060
" 20 . . . . .					500	1500			20	10	520	1510
" 27 . . . . .					480	1500			45	130	525	1630
Oct. 4 . . . . .					440	1000			38	100	478	1100
" 11 . . . . .					440	1300			20	40	460	1340
" 18 . . . . .									20	35	20	35
" 25 . . . . .												
Nov. 1 . . . . .					400	1200					400	1200
" 8 . . . . .					400	2360					400	2360
" 15 . . . . .												
" 22 . . . . .					250	240					250	240
" 29 . . . . .					160	150					160	150
Dec. 6 . . . . .					100	270					100	270
" 13 . . . . .					70	160					70	160
" 20 . . . . .					80	160					80	160
" 27 . . . . .					40	70					40	70
1857.												
To June 13 . . . . .					?	1716	?	15				
June 20 . . . . .					200	84	83	35			283	119
" 27 . . . . .					280	800	125	140	25	150	430	1090



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1857.												
July 4 . . . . .					375	1060	139	180	50	150	564	1390
" 11 . . . . .					480	1380	70	70	60	835	610	2285
" 18 . . . . .					480	1410	90	140	60	65	630	1615
" 25 . . . . .					480	1950	78	100	60	180	616	2230
Aug. 1 . . . . .					500	3000	64	50	54	120	618	3170
" 8 . . . . .					530	800	29	30	54	80	613	910
" 15 . . . . .					580	1000	10	10	34	40	624	1050
" 22 . . . . .					580	2500	10	10	34	40	624	2550
" 29 . . . . .					600	1300	8	10	34	40	642	1350
Sept. 5 . . . . .					600	1000	4	10	40	80	644	1090
" 12 . . . . .					540	600			80	220	620	820
" 19 . . . . .					540	400			80	80	620	480
" 26 . . . . .					500	600			60	60	560	660
Oct. 3 . . . . .					450	700			70	180	520	880
" 10 . . . . .					400	800			35	80	435	880
" 17 . . . . .					400	1200			35	100	435	1300
" 24 . . . . .					400	700					400	700
" 31 . . . . .					400	400					400	400
Nov. 7 . . . . .												
" 14 . . . . .												
" 21 . . . . .					300	1000					300	1000
" 28 . . . . .					100	200					100	200
1858.												
To June 5 . . . . .							?	*7	?	†500		
June 12 . . . . .							73	13			73	13
" 19 . . . . .							62	10			62	10
" 26 . . . . .					?	*3000	75	60			75	60
July 3 . . . . .					300	400	51	53			351	453
" 10 . . . . .					450	600	59	134	30	300	539	1034
" 17 . . . . .					480	450	96	900	100	25	666	1375
" 24 . . . . .					480	1100	119	50	100	175	699	1325
" 31 . . . . .					480	2050	53	750	150	300	683	3100
Aug. 7 . . . . .					450	1200	37	430	150	300	637	1543
" 14 . . . . .					480	1400	25	10	200	350	705	1760
" 21 . . . . .					480	1500	29	40	200	250	709	1790
" 28 . . . . .					480	950	9	15	180	180	669	1145
Sept. 4 . . . . .					520	1000			170	20	690	1020
" 11 . . . . .					520	1950			160	100	680	2050
" 18 . . . . .					500	800			100	60	600	860
" 25 . . . . .					500	900			80	20	580	920
Oct. 2 . . . . .					400	800					400	800
" 9 . . . . .					400	300					400	300
" 16 . . . . .					400	1030					400	1030
" 23 . . . . .					500	720					500	720
" 30 . . . . .					500	950					500	950

\* From 1st January.

† For January and February.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1858.												
Nov. 6	.	.	.	.	500	1100	.	.	.	.	500	1100
" 13	.	.	.	.	300	600	.	.	.	.	300	600
" 20	.	.	.	.	300	350	.	.	.	.	300	350
" 27	.	.	.	.	300	400	.	.	.	.	300	400
Dec. 4	.	.	.	.	250	450	.	.	.	.	250	450
" 11	.	.	.	.	200	300	.	.	.	.	200	300
" 18	.	.	.	.	100	550	.	.	.	.	100	550
" 25	.	.	.	.	100	100	.	.	.	.	100	100
" 31	.	.	.	.	100	1000	.	.	.	.	100	1000
1859.												
To June 11	.	.	.	.	?	*3209	.	.	.	.	.	.
June 18	.	.	.	.	220	196	?	*52	.	.	220	196
" 25	.	.	.	.	290	190	97	335	.	.	387	525
July 2	.	.	.	.	300	450	126	263	.	.	426	713
" 9	.	.	.	.	500	1643	127	420	60	160	687	2223
" 16	.	.	.	.	480	1800	135	255	100	140	715	2195
" 23	.	.	.	.	586	1405	123	195	100	100	809	1700
" 30	.	.	.	.	600	1207	78	80	80	40	758	1327
Aug. 6	.	.	.	.	600	1125	50	.	80	60	730	1185
" 13	.	.	.	.	600	800	33	25	80	100	713	925
" 20	.	.	.	.	600	510	28	15	100	20	728	545
" 27	.	.	.	.	600	315	12	10	100	50	712	375
Sept. 3	.	.	.	.	600	400	.	.	.	.	600	400
" 10	.	.	.	.	600	780	.	.	.	.	600	780
" 17	.	.	.	.	600	800	.	.	.	.	600	800
" 24	.	.	.	.	450	620	.	.	.	.	450	620
Oct. 1	.	.	.	.	400	180	.	.	.	.	400	180
" 8	.	.	.	.	400	470	.	.	.	.	400	470
" 15	.	.	.	.	400	624	.	.	.	.	400	624
" 22	.	.	.	.	380	566	.	.	.	.	380	566
" 29	.	.	.	.	390	84	.	.	.	.	390	84
Nov. 5	.	.	.	.	300	200	.	.	21	60	321	260
" 12	.	.	.	.	340	100	.	.	60	150	400	250
" 19	.	.	.	.	310	369	.	.	50	140	360	509
" 26	.	.	.	.	400	3900	.	.	50	200	450	4100
Dec. 3	.	.	.	.	400	2900	.	.	.	.	400	2900
" 10	.	.	.	.	150	100	.	.	.	.	150	100
" 17	.	.	.	.	500	2000	.	.	.	.	500	2000
" 24	.	.	.	.	300	3000	.	.	.	.	300	3000
" 31	.	.	.	.	250	452	.	.	.	.	250	452
1860.												
Jan. 7	.	.	.	.	100	300	.	.	.	.	100	300
" 14	.	.	.	.	90	470	.	.	.	.	90	470
" 21	.	.	.	.	80	.	.	.	.	.	80	.
" 28	.	.	.	.	50	10	.	.	.	.	50	10

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1860.													
Feb.	4	.	.	.	.	35	15	.	.	.	.	35	15
"	11	.	.	.	.	30	23	.	.	.	.	30	23
"	18	.	.	.	.	30	181	.	.	.	.	30	181
"	25	.	.	.	.	50	505	.	.	.	.	50	505
March	3	.	.	.	.	30	270	.	.	.	.	30	270
"	10	.	.	.	.	40	366	.	.	.	.	40	366
"	17	.	.	.	.	35	195	.	.	.	.	35	195
"	24	.	.	.	.	60	630	.	.	.	.	60	630
"	31	.	.	.	.	60	294	.	.	.	.	60	294
April	7	.	.	.	.	50	116	.	.	.	.	50	116
"	14	.	.	.	.	50	152	.	.	.	.	50	152
"	21	.	.	.	.	40	75	.	.	.	.	40	75
"	28	.	.	.	.	30	45	.	.	.	.	30	45
May	5	.	.	.	.	30	141	.	.	.	.	30	141
"	12	.	.	.	.	20	.	.	.	.	.	20	.
"	19	.	.	.	.	16	24	.	.	.	.	16	24
"	26	.	.	.	.	22	60	.	.	.	.	22	60
June	2	.	.	.	.	35	42	.	.	.	.	35	42
"	9	.	.	.	.	95	68	?	*17	.	.	95	68
"	16	.	.	.	.	238	188	86	88	.	.	324	276
"	23	.	.	.	.	458	480	92	50	.	.	550	530
"	30	.	.	.	.	450	320	111	65	.	.	561	385
July	7	.	.	.	.	442	473	113	80	.	.	555	553
"	14	.	.	.	.	470	807	132	100	100	50	702	957
"	21	.	.	.	.	550	947	131	210	60	30	741	1187
"	28	.	.	.	.	550	999	123	110	110	160	783	1269
Aug.	4	.	.	.	.	550	680	115	380	175	460	840	1520
"	11	.	.	.	.	540	500	129	400	180	480	849	1380
"	18	.	.	.	.	500	600	118	320	210	520	828	1440
"	25	.	.	.	.	550	2400	78	280	280	840	908	3520
Sept.	1	.	.	.	.	550	450	53	270	250	770	853	1490
"	8	.	.	.	.	550	1300	55	140	260	590	865	2030
"	15	.	.	.	.	500	320	54	80	230	570	784	970
"	22	.	.	.	.	550	950	45	70	230	530	825	1550
"	29	.	.	.	.	550	2300	42	240	230	300	822	2840
Oct.	6	.	.	.	.	560	800	26	50	240	400	826	1250
"	13	.	.	.	.	460	1100	.	.	200	500	660	1600
"	20	.	.	.	.	410	1500	.	.	200	600	610	2100
"	27	.	.	.	.	390	1720	.	.	200	700	590	2420
Nov.	3	.	.	.	.	420	2600	.	.	170	300	590	2900
"	10	.	.	.	.	430	4500	.	.	100	150	530	4650
"	17	.	.	.	.	400	1930	.	.	100	50	500	1980
"	24	.	.	.	.	380	1320	.	.	60	60	440	1380

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Cranes	Boats	Cranes	Boats	Cranes	Boats	Cranes	Boats	Cranes	Boats	Cranes
1860.												
Dec. 1	.	.	.	.	380	110	.	.	12	60	392	170
" 8	.	.	.	.	208	1950	.	.	100	350	308	2300
" 15	.	.	.	.	228	2450	.	.	130	500	358	2950
" 22	.	.	.	.	190	2430	.	.	.	.	190	2430
" 29	.	.	.	.	85	660	.	.	.	.	85	660
1861.												
June 8	.	.	.	.	172	132	.	.	6	.	178	132
" 15	.	.	.	.	195	97	.	.	15	1	210	97½
" 22	.	.	.	.	260	12	?	*50	12	1	272	12½
" 29	.	.	.	.	454	161	121	45	30	9	605	215
July 6	.	.	.	.	495	432	115	25	80	41	690	498
" 13	.	.	.	.	560	690	110	80	150	40	820	810
" 20	.	.	.	.	600	764	93	80	150	100	843	944
" 27	.	.	.	.	600	1019	115	350	150	350	865	1719
Aug. 3	.	.	.	.	570	808	105	50	110	70	785	928
" 10	.	.	.	.	565	1335	46	50	90	30	701	1370
" 17	.	.	.	.	565	1980	14	15	100	70	679	2065
" 24	.	.	.	.	565	400	8	20	90	110	663	530
" 31	.	.	.	.	565	800	8	5	120	180	693	985
Sept. 7	.	.	.	.	515	890	.	.	.	.	515	890
" 14	.	.	.	.	515	890	.	.	.	.	515	890
" 21	.	.	.	.	615	1215	.	.	.	.	615	1215
" 28	.	.	.	.	615	707	.	.	50	100	665	807
Oct. 5	.	.	.	.	550	431	.	.	200	200	750	631
" 12	.	.	.	.	570	532	.	.	180	170	750	702
" 19	.	.	.	.	470	672	.	.	180	300	650	972
" 26	.	.	.	.	450	325	.	.	180	250	630	575
Nov. 2	.	.	.	.	350	375	.	.	190	250	540	625
" 9	.	.	.	.	340	162	.	.	150	200	490	362
" 16	.	.	.	.	340	29	.	.	150	150	490	179
" 23	.	.	.	.	310	72	.	.	140	30	450	102
" 30	.	.	.	.	200	117	.	.	60	30	260	147
Dec. 7	.	.	.	.	267	474	.	.	60	50	327	524
" 14	.	.	.	.	320	960	.	.	.	.	320	960
" 21	.	.	.	.	350	120	.	.	.	.	350	120
" 28	.	.	.	.	200	170	.	.	.	.	200	170
" 31	.	.	.	.	150	80	.	.	.	.	150	80
1862.												
June 7	.	.	.	.	30	.	?	*4	.	.	30	.
" 14	.	.	.	.	70	2	85	13	.	.	155	15
" 21	.	.	.	.	190	103	81	18	.	.	271	121
" 28	.	.	.	.	260	102	91	35	.	.	351	137
July 5	.	.	.	.	260	117	94	90	20	2	374	209
" 12	.	.	.	.	400	149	111	140	30	13	541	302
" 19	.	.	.	.	500	605	133	227	50	85	683	917
" 26	.	.	.	.	530	1021	135	157	60	80	725	1258

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1862.												
Aug. 2 .	.	.	.	.	580	1070	139	282	62	75	781	1427
" 9 .	.	.	.	.	600	2020	159	721	123	460	882	3201
" 16 .	.	.	.	.	600	1570	155	725	106	325	861	2620
" 23 .	.	.	.	.	585	2660	143	708	110	505	838	3873
" 30 .	.	.	.	.	715	3435	130	410	75	305	920	4150
Sept. 6 .	.	.	.	.	705	2760	124	325	70	200	899	3285
" 13 .	.	.	.	.	680	2275	108	470	40	75	828	2820
" 20 .	.	.	.	.	670	2880	88	280	29	50	787	3210
" 27 .	.	.	.	.	675	3810	81	600	.	.	756	4410
Oct. 4 .	.	.	.	.	687	3520	41	45	.	.	728	3565
" 11 .	.	.	.	.	690	3725	22	10	.	.	712	3735
" 18 .	.	.	.	.	687	2911	.	.	.	.	687	2911
" 25 .	.	.	.	.	574	1690	.	.	.	.	574	1690
Nov. 1 .	.	.	.	.	682	3074	.	.	.	.	682	3074
" 8 .	.	.	.	.	770	3778	.	.	3	21	773	3799
" 15 .	.	.	.	.	773	4212	.	.	5	46	778	4258
" 22 .	.	.	.	.	670	2730	.	.	2	22	672	2752
" 29 .	.	.	.	.	610	2399	.	.	.	.	610	2399
Dec. 6 .	.	.	.	.	400	432	.	.	.	.	400	432
" 13 .	.	.	.	.	500	2700	.	.	.	.	500	2700
" 20 .	.	.	.	.	450	961	.	.	.	.	450	961
" 27 .	.	.	.	.	350	600	.	.	4	20	354	620
" 31 .	.	.	.	.	150	50	.	.	.	.	150	50
1863.												
June 6 .	63	115	.	.	85	6	?	*49	.	.	148	121
" 13 .	76	118½	50	40	145	45	55	44	.	.	326	247½
" 20 .	73	85½	70	30	181	39	42	10	.	.	366	164½
" 27 .	74	63	110	140	230	75	37	26	17	8	468	312
July 4 .	71	46½	138	526	320	82	47	52	12	10	588	716½
" 11 .	58	21½	150	304	340	177	39	20	50	28	637	550½
" 18 .	68	101	140	427	375	513	54	124	60	154	697	1319
" 25 .	68	100	89	250	452	930	60	147	75	160	744	1587
Aug. 1 .	60	99	69	167	470	751	56	113	75	180	730	1310
" 8 .	48	50	20	8	747	1725	35	52	60	260	910	2095
" 15 .	41	20	9	7	650	1443	48	47	60	60	808	1577
" 22 .	30	.	40	36	620	1430	35	12	40	10	772	1488
" 29 .	17	5	29	7	690	1354	18	11	35	10	789	1387
" 5 .	1	.	5	2	705	1120	10	8	26	15	747	1145
" 12 .	1	.	18	3½	700	820	5	3	30	55	754	881½
" 19 .	.	.	.	.	680	740	1	.	30	30	711	770
" 26 .	1	.	.	.	630	957	2	2	15	7	648	966
Oct. 3 .	.	.	.	.	560	504	6	½	15	3	581	507½
" 10 .	.	.	.	.	487	1250	.	.	15	4	502	1254
" 17 .	.	.	.	.	650	1346	.	.	3	1	653	1347
" 24 .	.	.	.	.	716	1678	.	.	200	180	916	1858
" 31 .	.	.	.	.	605	1419	.	.	45	43	650	1462

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1863.												
Nov. 7 .	.	.	.	.	530	968	.	.	15	25	545	993
" 14 .	.	.	.	.	532	719	.	.	100	147	632	866
" 21 .	.	.	.	.	460	683	.	.	100	120	560	803
" 28 .	.	.	.	.	411	800	.	.	110	300	521	1100
Dec. 5 .	.	.	.	.	426	905	.	.	80	132	506	1037
" 12 .	.	.	.	.	365	394	.	.	75	250	440	644
" 19 .	.	.	.	.	30	50	.	.	240	1200	270	1250
" 26 .	.	.	.	.	.	.	.	.	190	1100	190	1100
" 31 .	.	.	.	.	.	.	.	.	40	150	40	150
1864.												
June 4 .	57	2	.	.	62	6	?	*1	.	.	119	8
" 11 .	70	11	27	20	215	31½	12	1	.	.	324	63½
" 18 .	75	25	70	100	275	134	12	1	.	.	432	260
" 25 .	74	62	156	345	355	400	25	40	.	.	560	847
July 2 .	79	158	143	396	450	277½	27	70	.	.	699	901½
" 9 .	79	192	121	525	545	335	41	80	38	47	824	1179
" 16 .	80	80½	122	678	560	772	43	98	280	840	1085	2468½
" 23 .	76	181½	78	207	575	572	55	209	140	269	924	1438½
" 30 .	49	52	94	138	456	735	45	95	140	244	784	1264
Aug. 6 .	43	43	70	103	473	618	50	77	270	300	906	1141
" 13 .	31	11	61	68	455	418	43	54	240	100	830	651
" 20 .	15	7	48	87	493	279	52	66	109	39	717	478
" 27 .	10	5	64	100	456	1352	37	54	112	121	679	1632
Sept. 3 .	7	4	22	14	460	540	17	.	90	34	596	592
" 10 .	4	6	3	1½	433	239	.	.	60	22	500	268½
" 17 .	2	2	18	28½	545	1120	5	5	45	64	615	1219½
" 24 .	.	.	18	35	540	570	26	20	100	160	684	785
Oct. 1 .	.	.	8	5½	530	755	9	13	100	600	647	1373½
" 8 .	2	2	2	.	470	725	10	20	124	700	608	1447
" 15 .	1	4	.	.	405	338	2	1	264	3033	672	3376
" 22 .	.	.	.	.	300	279	3	36	95	34	398	349
" 29 .	2	2	.	.	430	926	.	.	180	500	612	1428
Nov. 5 .	4	11*	.	.	240	551	13	55	350	5200	607	5817
" 12 .	7	18	.	.	121	526	21	109	360	2500	509	3153
" 19 .	6	11	.	.	60	226	26	69	320	2600	412	2906
" 26 .	2	7	.	.	50	112	20	95	310	2280	382	2494
Dec. 3 .	.	.	.	.	28	18	.	.	330	2330	358	2348
" 10 .	.	.	.	.	18	7	8	.	400	4364	426	4371
" 17 .	3	6	.	.	9	5	12	1	360	5500	384	5512
" 24 .	.	.	.	.	.	.	10	3	200	1823	210	1826
" 31 .	.	.	.	.	.	.	.	.	200	2614	200	2614
1865.												
June 3 .	24	1	.	.	64	5	.	.	.	.	88	6
" 10 .	53	6	34	50	115	16	13	4	.	.	215	76
" 17 .	45	9	134	100	163	52	13	1½	.	.	355	162½
" 24 .	46	32	116	80	239	42	29	11½	.	.	430	165½

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1865.													
July	1	59	39	80	140	258	34	29	7	14	10	440	230
"	8	67	67	144	420	335	142	26	22	80	140	652	791
"	15	50	106	118	296	605	594	29	83	170	220	972	1299
"	22	44	67	48	121	580	1007	65	31	90	200	827	1426
"	29	40	43	75	330	560	578	56	113	90	130	821	1194
Aug.	5	53	190	110	340	570	1003	74	367	209	650	1016	2550
"	12	49	120	72	284	595	2683	54	360	239	800	1009	4247
"	19	49	220	89	220	510	2020	58	300	240	750	946	3510
"	26	30	62	48	139	580	2520	55	120	240	1600	953	4441
Sept.	2	4	4	22	29	600	4180	24	53	210	742	860	5008
"	9	2	14	1	5	645	2356	8	27	120	218	776	2620
"	16	2	2	2	3	550	3120	4	8	75	220	633	3351
"	23	2	10	2	4	460	980	12	82	500	1720	976	2796
"	30	.	.	1	1	380	1425	9	115	500	600	890	2141
Oct.	7	.	.	1	1	335	410	4	22	550	1650	890	2083½
"	14	.	.	.	.	237	369	3	36	500	3000	740	3405
"	21	.	.	.	.	220	486	3	21	400	2000	623	2507
"	28	.	.	.	.	326	877	6	34	120	300	452	1211
Nov.	4	4	33	.	.	195	225	35	920	20	15	254	1193
"	11	16	131	.	.	290	395	62	890	220	400	588	1816
"	18	16	199	.	.	210	246	65	352	400	2400	691	3197
"	25	29	959	.	.	45	18	5	1	450	2084	529	3062
Dec.	2	36	393	.	.	.	.	32	159	500	2087	568	2639
"	9	32	390	.	.	10	85	49	160	500	3800	591	4435
"	16	38	888	.	.	8	250	33	130	500	2700	579	3968
"	23	40	337	.	.	.	.	27	265	500	3600	567	4202
"	30	5	80	.	.	.	.	30	300	400	6400	435	6780
1866.													
Jan.	6	.	.	.	.	.	.	31	405	320	2000	351	2405
"	13	3	1	.	.	.	.	27	32	160	2500	190	2533
"	20	.	.	.	.	.	.	3	.	200	2000	203	2000
"	27	.	.	.	.	.	.	3	.	60	660	63	660
"	29-31	.	.	.	.	.	.	1	.	40	300	41	300
June	2	.	.	.	.	24	4	8	2	.	.	32	6
"	9	42	27	25	62	130	37	21	6	.	.	218	132
"	16	53	25	90	108	160	73	26	13	.	.	329	219
"	23	52	42	108	108	176	101	25	7	.	.	361	258
"	30	55	13	135	122	240	240	26	10	.	.	456	385
July	7	50	48	160	230	365	462	44	40	40	29	659	809
"	14	63	108	80	146	345	234	69	90	90	74	647	652
"	21	56	183	72	164	356	360	74	130	60	83	618	920
"	28	50	232	83	131	520	617	91	320	70	120	814	1420
Aug.	4	51	239	84	200	450	602	83	181	110	452	778	1674
"	11	33	84	57	189	500	1270	53	70	200	790	843	2403
"	18	39	23	83	275	460	228	61	168	90	566	733	3260
"	25	13	27	57	175	545	2165	49	41	80	341	744	2749

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde  
Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1866.													
Sept.	1	5	11	43	73	525	1585	37	46	89	306	699	2021
"	8	3	4	22	36	576	2440	9	26	70	372	680	2878
"	15	3	2	4	1	474	908	2	4	40	100	523	1015
"	22	.	.	.	.	550	1384	3	6	40	.	593	1390
"	29	.	.	.	.	450	570	2	1	50	107	502	678
Oct.	6	.	.	.	.	600	3260	2	13	70	120	672	3393
"	13	2	21	.	.	410	3696	11	106	300	1962	713	5785
"	20	.	.	.	.	490	1588	4	13	4	96	498	1697
"	27	.	.	.	.	475	1203	1	.	230	920	706	2123
Nov.	3	3	38	.	.	375	1108	44	487	400	3500	822	5133
"	10	12	185	.	.	200	239	28	75	450	3800	690	4299
"	17	16	65	.	.	175	215	39	305	500	4999	730	5584
"	21	90	934	.	.	162	486	28	60	350	1800	630	3280
Dec.	1	18	70	.	.	155	510	8	.	400	1600	581	2180
"	8	12	6	.	.	140	445	33	43	450	500	635	994
"	15	10	1	.	.	105	120	32	24	450	900	597	1045
"	22	6	.	.	.	113	130	11	.	230	800	360	930
"	29	.	.	.	.	103	80	5	.	230	3500	338	3580
1867.													
Jan.	5	.	.	.	.	90	217	23	149	220	2300	333	2666
"	12	14	4	.	.	70	200	25	83	200	2000	309	2287
"	19	.	.	.	.	15	10	31	70	130	2860	176	2940
"	26	20	62	.	.	5	.	13	7	100	3800	138	3869
Feb.	2	13	4	.	.	.	.	.	.	60	1800	73	1804
June	1	.	.	.	.	.	.	5	$\frac{1}{2}$	.	.	5	$\frac{1}{2}$
"	8	39	30	36	60	52	55	22	3	.	.	149	148
"	15	44	47	63	105	89	124	14	7	.	.	210	283
"	22	55	23	157	284	216	260	19	6	.	.	447	573
"	29	53	26	70	127	350	332	30	11 $\frac{1}{2}$	.	.	503	496 $\frac{1}{2}$
July	6	53	87	102	244	355	295	28	18	.	.	538	644
"	13	57	92	111	252	325	952	60	98	.	.	553	1394
"	20	55	84	60	144	410	788	46	46	.	.	571	1062
"	27	59	41	61	87	483	1238	23	14	.	.	626	1380
Aug.	3	50	110	87	256	360	3096	30	61	65	70	592	3593
"	10	38	70	62	127	386	4193	70	170	60	67	616	4627
"	17	37	60	66	108	335	1316	35	84	60	103	533	1671
"	24	40	45	47	119	410	2041	30	52	55	85	582	2342
"	31	34	45	40	99	430	2810	33	36	52	75	589	3065
Sept.	7	2	.	26	25	507	2089	42	44	40	43	617	2201
"	14	1	.	1	1	527	981	14	27	25	37	568	1046
"	21	.	.	.	.	500	1467	27	13	32	50	559	1530
"	28	.	.	.	.	450	1764	16	14	46	90	512	1868
Oct.	5	.	.	.	.	340	611	.	.	44	40	384	651
"	12	.	.	.	.	320	989	9	7	25	14	354	1010
"	19	.	.	.	.	310	451	3	9	46	120	359	580
"	26	.	.	.	.	395	1050	8	16	260	340	663	1406



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1867.													
Nov.	2	.	.	.	.	127	755	6	36	450	4500	583	5291
"	9	.	.	.	.	125	391	7	51	200	1340	332	1782
"	16	3	65	.	.	130	435	5	47	150	400	288	947
"	23	5	10	.	.	174	1595	4	20	28	607	211	2232
"	30	2	21	.	.	180	1470	.	.	35	730	217	2221
Dec.	7	.	.	.	.	170	705	6	.	70	550	246	1255
"	14	.	.	.	.	140	855	3	10	250	610	393	1475
"	21	2	30	.	.	124	190	5	36	250	3100	381	3356
"	28	.	.	.	.	145	530	9	20	130	3060	284	3610
"	31	.	.	.	.	125	160	.	.	.	.	125	160
1868.													
Jan.	4	14	66	.	.	135	525	.	.	8	60	157	651
"	11	2	14	.	.	145	695	.	.	150	1071	297	1780
"	18	.	.	.	.	130	630	.	.	100	454	230	1084
"	25	.	.	.	.	125	1130	.	.	80	1290	205	2420
Feb.	1	.	.	.	.	45	50	.	.	80	60	125	110
"	8	.	.	.	.	.	.	.	.	.	.	.	.
June	6	.	.	27	60	166	530	.	.	.	.	193	590
"	13	.	.	58	49	175	765	.	.	.	.	233	814
"	20	.	.	80	144	185	1045	.	.	.	.	265	1189
"	27	.	.	55	100	220	700	?	*20	.	.	275	800
July	4	.	.	61	191	220	1285	24	30	.	.	305	1506
"	11	?	306†	61	188	280	1775	18	32	.	.	359	1995
"	18	46	124	50	145	301	2035	54	120	.	.	451	2424
"	25	54	141	68	110	316	1800	24	131	30	54	492	2236
Aug.	1	48	144	50	65	370	2510	46	263	33	66	547	3048
"	8	57	164	26	64	380	1955	47	192	37	182	547	2557
"	15	40	70	34	70	410	2680	40	80	30	53	554	2953
"	22	45	218	47	155	415	1920	34	110	30	57	571	2460
"	29	.	.	52	68	368	830	6	19	10	13	436	930
Sept.	5	3	3	59	302	420	2179	22	228	43	320	547	3032
"	12	12	57	21	21	434	2286	20	115	30	130	517	2609
"	19	18	137	.	.	450	3058	14	60	30	60	512	3315
"	26	10	18	.	.	485	1981	16	25	26	50	537	2074
Oct.	3	7	25	.	.	353	1084	13	80	40	180	413	1369
"	10	9	33	.	.	398	2019	36	194	65	200	508	2446
"	17	3	15	.	.	426	1363	36	383	120	400	585	2161
"	24	6	25	.	.	440	1445	45	1022	110	150	601	2642
"	31	.	.	.	.	205	210	98	1500	60	.	363	1710
Nov.	7	2	11	.	.	75	45	180	2496	.	.	257	2552
"	14	3	30	.	.	30	30	320	5800	.	.	353	5860
"	21	5	160	.	.	32	45	340	6000	8	160	385	6365
"	28	2	11	.	.	32	60	320	5500	4	68	358	5639

\* From 1st January.

† From 11th January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1868.												
Dec. 5 .	1	5	.	.	26	25	300	2600	6	80	333	2710
" 12 .	.	.	.	.	65	370	340	3500	6	.	411	3870
" 19 .	4	13	.	.	75	510	340	3000	90	1350	509	4873
" 26 .	5	10	.	.	12	225	40	120	140	1904	197	2259
" 31 .	.	.	.	.	.	.	12	20	250	1300	262	1320
1869.												
Jan. 2 .	.	.	.	.	2	15	.	.	.	.	2	15
" 9 .	5	.	.	.	36	560	.	.	300	1500	341	2060
" 16 .	1	.	.	.	72	140	.	.	260	1200	333	1340
" 23 .	2	.	.	.	70	50	?	*260	200	400	272	450
" 30 .	.	.	.	.	4	4	70	210	8	250	82	464
June 5 .	52	136	32	75	156	475	4	20	36	80	280	786
" 12 .	52	145	38	200	195	530	23	27	40	74	348	976
" 19 .	50	92	56	250	194	930	26	30	50	110	376	1412
" 26 .	52	52	86	580	231	1610	27	24	52	142	448	2408
July 3 .	61	119	94	225	244	1355	40	56	.	.	439	1755
" 10 .	63	219	101	255	366	780	50	90	.	.	580	1344
" 17 .	60	236	78	430	339	1370	52	109	.	.	529	2245
" 24 .	70	289	108	570	396	1705	58	165	.	.	632	2729
" 31 .	65	262	163	501	402	1269	52	286	.	.	682	2318
Aug. 7 .	53	151	105	506	383	1849	56	293	.	.	597	2799
" 14 .	44	164	80	587	390	3001	71	294	31	117	616	4163
" 21 .	40	112	206	1202	424	2905	45	234	29	120	744	4573
" 28 .	37	107	182	1057	368	1509	51	215	100	700	738	3588
Sept. 4 .	11	38	94	538	364	3543	39	142	98	483	606	4744
" 11 .	.	.	138	235	326	2456	33	40	70	287	567	3018
" 18 .	1	6	34	80	404	1135	17	36	120	680	576	1937
" 25 .	7	7	7	90	392	579	118	53	100	70	624	718
Oct. 2 .	.	.	12	67	369	874	161	205	60	45	602	1191
" 9 .	9	5	18	79	434	2158	180	12	250	740	891	2994
" 16 .	4	.	.	.	400	1145	174	43	360	2040	938	3228
" 23 .	6	2	.	.	135	302	400	2996	130	390	671	3690
" 30 .	9	18	.	.	36	95	480	6000	50	260	575	6373
Nov. 6 .	.	.	.	.	16	245	500	3200	63	280	579	3725
" 13 .	.	.	.	.	10	10	200	120	330	1200	540	1330
" 20 .	5	5	.	.	4	5	30	14	400	1800	439	1824
" 27 .	.	.	.	.	.	.	120	844	400	2300	520	3144
Dec. 4 .	6	14	.	.	14	35	180	302	500	3200	700	3551
" 11 .	.	.	.	.	32	135	.	.	500	3750	532	3885
" 18 .	.	.	.	.	74	490	.	.	350	1400	424	1890
" 25 .	.	.	.	.	85	465	12	200	200	250	297	915
" 31 .	.	.	.	.	85	295	9	150	150	225	244	670
1870.												
Jan. 1 .	.	.	.	.	55	25	.	.	.	.	55	25
" 8 .	7	2	.	.	80	145	30	300	250	700	367	1147
" 15 .	.	.	.	.	70	210	.	.	200	900	270	1110
" 22 .	17	9	.	.	85	320	.	.	200	400	302	729
" 29 .	13	3	.	.	56	225	.	.	150	450	219	678

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1870.													
Winter & Spring.		?	1635	.	.	.	.	.	.	.	.	.	.
May	28	48	113	.	.	.	.	.	.	.	.	48	113
June	4	53	62	.	.	165	500	.	.	.	.	218	562
"	11	66	152	24	200	205	695	39	62	.	.	334	1109
"	18	67	523	44	304	210	305	47	54	.	.	368	1186
"	25	69	690	57	245	255	1185	59	224	.	.	440	2344
July	2	77	515	102	964	255	895	57	212	.	.	491	2586
"	9	80	485	91	689	318	860	54	217	40	480	583	2731
"	16	78	467	115	535	340	1190	41	229	50	400	624	2821
"	23	74	229	164	900	331	1505	71	404	70	350	710	3388
"	30	37	64	95	588	426	2417	70	296	65	140	693	3505
Aug.	6	47	94	98	641	386	1309	62	152	64	130	657	2326
"	13	30	50	232	859	384	800	61	158	60	300	767	2167
"	20	11	38	204	660	358	1283	63	250	130	360	766	2591
"	27	.	.	168	642	394	1778	49	84	130	300	741	2804
Sept.	3	.	.	163	78	518	1041	41	66	120	160	842	1345
"	10	.	.	127	152	385	544	8	4	132	210	652	910
"	17	15	16	81	174	297	102	53	113	118	123	564	528
"	24	.	.	95	165	350	869	50	60	140	240	635	1334
Oct.	1	.	.	75	65	335	533	60	75	200	400	670	1073
"	8	4	4	146	500	375	994	40	40	160	260	725	1798
"	15	.	.	22	20	389	939	40	20	100	130	551	1109
"	22	.	.	.	.	367	1045	40	20	30	100	437	1165
"	29	9	13	4	4	303	725	24	22	200	560	540	1324
Nov.	5	13	24	2	13	391	1620	32	64	260	850	698	2571
"	12	10	11	16	76	312	740	16	68	240	731	594	1626
"	19	.	.	13	35	331	765	.	.	115	300	459	1100
"	26	.	.	.	.	300	550	12	108	100	260	412	918
Dec.	3	.	.	.	.	215	325	60	598	450	4500	725	5423
"	10	5	101	.	.	80	80	20	150	200	450	305	781
"	17	.	.	.	.	39	25	20	200	300	2400	359	2625
"	24	.	.	.	.	23	170	30	100	230	600	283	870
"	31	.	.	.	.	31	195	.	.	180	1050	211	1245
1871.													
Jan.	7	.	.	.	.	16	140	.	.	200	900	216	1040
"	14	.	.	.	.	54	985	.	.	180	1000	234	1985
"	21	.	.	.	.	50	500	.	.	150	2000	200	2500
"	28	22	35	.	.	40	215	?	*40	130	360	192	610
Winter & Spring.		?	1621	.	.	.	.	.	.	.	.	.	.
May	20	51	64	.	.	.	.	.	.	.	.	51	64
"	27	65	75	.	.	.	.	.	.	.	.	65	75

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued.*

Week ended		Ballantrae.		Campbelltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1871.													
June	3 .	77	85	.	.	127	230	.	.	.	.	204	315
"	10 .	84	140	45	181	165	635	?	*35	.	.	294	956
"	17 .	80	145	73	200	231	530	43	72	.	.	427	947
"	24 .	90	111	102	501	348	865	51	115	56	300	647	1892
July	1 .	89	169	104	262	402	1155	57	192	80	500	732	2278
"	8 .	89	85	94	267	410	1325	55	144	86	360	734	2181
"	15 .	69	64	94	276	374	550	46	32	80	50	663	972
"	22 .	56	31	252	352	388	400	53	37	65	15	814	835
"	29 .	24	14	326	363	466	277	30	20	50	30	896	704
Aug.	5 .	12	7	316	481	350	249	34	23	110	120	822	880
"	12 .	5	.	234	371	278	647	32	25	250	500	799	1543
"	19 .	6	5	230	348	292	410	33	31	200	300	761	1094
"	26 .	.	.	148	120	224	274	5	6	260	295	637	695
Sept.	2 .	.	.	188	141	268	820	16	58	112	100	584	1119
"	9 .	5	5	142	131	295	203	2	.	150	110	594	449
"	16 .	.	.	132	333	211	213	12	16	140	190	495	752
"	23 .	.	.	136	344	227	200	10	4	130	100	503	648
"	30 .	.	.	78	102	84	101	.	.	130	125	292	328
Oct.	7 .	.	.	44	20	150	333	12	6	50	20	256	379
"	14 .	.	.	96	194	160	1035	10	10	30	12	296	1251
"	21 .	2	9	35	76	292	624	4	6	.	.	333	715
"	28 .	6	20	.	.	160	90	.	.	6	6	172	116
Nov.	4 .	4	2	.	.	41	124	8	8	.	.	53	134
"	11 .	.	.	.	.	70	160	50	58	8	96	128	314
"	18 .	.	.	.	.	109	60	50	220	30	.	189	280
"	25 .	.	.	.	.	41	80	30	102	260	1200	331	1382
Dec.	2 .	.	.	.	.	20	45	80	300	550	3400	650	3745
"	9 .	.	.	.	.	18	40	70	700	250	1500	338	2240
"	16 .	1	10	.	.	4	.	.	.	370	1000	375	1010
"	23 .	.	.	.	.	6	.	.	.	200	500	206	500
"	30 .	.	.	.	.	6	.	.	.	250	1500	256	1500
1872.													
Jan.	6 .	.	.	.	.	.	.	.	.	250	30	250	30
"	13 .	.	.	.	.	.	.	.	.	200	150	200	150
"	20 .	.	.	.	.	2	.	.	.	100	.	102	.
"	27 .	.	.	.	.	8	.	.	.	.	.	8	.
Winter & Spring.		?	1725	.	.	.	.	.	.	.	.	.	.
June	1 .	19	5	.	.	101	70	.	.	.	.	120	75
"	8 .	53	16	39	37	127	163	.	.	.	.	219	216
"	15 .	65	11	70	47	137	188	.	.	.	.	272	246
"	22 .	52	8	79	66	149	139	.	.	.	.	280	213
"	29 .	58	21	98	136	147	155	.	.	.	.	303	312
July	6 .	64	44	180	500	163	195	?	*15	.	.	407	739
"	13 .	64	50	158	320	261	320	25	25	.	.	508	715
"	20 .	50	20	242	940	239	300	35	13	.	.	566	127
"	27 .	39	25	368	2485	289	735	30	24	95	80	821	334

\* From 1st June.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1872.													
Aug.	3	38	33	268	669	332	617	46	50	80	90	764	1459
"	10	30	27	350	1719	352	343	15	15	120	130	867	2234
"	17	39	87	380	401	307	310	21	28	170	120	917	946
"	24	35	137	399	645	329	507	19	24	120	280	902	1593
"	31	15	11	319	947	270	205	13	24	135	120	752	1307
Sept.	7	.	.	234	873	263	335	8	26	200	370	705	1604
"	14	.	.	180	560	169	38	4	20	100	70	453	688
"	21	.	.	224	2012	180	315	8	7	80	60	492	2394
"	28	.	.	226	780	250	573	13	29	150	220	639	1602
Oct.	5	.	.	190	230	260	365	11	60	90	300	551	685
"	12	4	10	180	2051	68	95	17	110	95	85	364	2351
"	19	.	.	6	10	63	30	15	45	60	165	144	250
"	26	.	.	4	4	14	4	5	26	500	260	523	294
Nov.	2	.	.	.	.	7	5	4	3	350	340	361	348
"	9	5	10	.	.	.	.	.	.	345	650	350	660
"	16	.	.	.	.	87	430	4	3	340	1500	431	1933
"	23	.	.	.	.	240	950	4	6	300	1400	544	2356
"	30	.	.	.	.	176	850	.	.	290	740	466	1590
Dec.	7	.	.	.	.	256	700	.	.	300	1200	556	1900
"	14	.	.	.	.	36	120	.	.	300	600	336	720
"	21	.	.	.	.	.	.	.	.	180	185	180	185
"	28	.	.	.	.	.	.	.	.	120	260	120	260
1873.													
Jan.	4	.	.	.	.	.	.	.	.	65	120	65	120
"	11	.	.	.	.	.	.	.	.	150	50	150	50
"	18	.	.	.	.	.	.	.	.	50	.	50	.
"	25	.	.	.	.	.	.	.	.	5	.	5	.
"	31	.	.	.	.	.	.	.	.	.	.	.	.
Winter & Spring.		?	2025	.	.	.	.	.	.	.	.	.	.
May	31	26	42	.	.	.	.	.	.	.	.	26	42
June	7	46	39	?	82	115	250	.	.	.	.	161	371
"	14	57	95	47	187	122	125	17	13	.	.	243	420
"	21	62	109	67	236	137	360	20	7	.	.	286	712
"	28	66	129	65	206	174	310	30	55	90	50	425	750
July	5	73	244	138	300	194	520	39	91	100	220	544	1375
"	12	74	202	99	504	266	370	56	148	100	60	595	1284
"	19	66	174	1581	186	214	275	53	166	64	60	555	1861
"	26	65	322	7422	181	213	263	57	236	70	70	1147	3072
Aug.	2	58	243	5022	115	136	379	50	150	126	294	872	3181
"	9	42	130	6181	001	16	13	43	150	49	48	768	1342
"	16	35	32	413	897	36	12	14	9	76	40	574	990
"	23	22	34	4681	552	56	16	20	32	96	160	662	1794
"	30	.	.	520	656	104	93	2	5	100	120	726	874

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1873.												
Sept. 6 .	.	.	344	844	94	52	12	53	100	234	550	1183
" 13 .	4	20	151	167	30	50	.	.	138	532	323	769
" 20 .	6	17	156	531	20	100	2	10	84	82	268	740
" 27 .	7	21	2821	960	20	36	11	45	100	370	420	2432
Oct. 4 .	.	.	153	632	140	160	14	23	120	360	427	1175
" 11 .	5	20	23	49	20	94	22	252	100	180	170	595
" 18 .	.	.	118	590	35	170	18	63	34	86	205	909
" 25 .	.	.	40	15	65	.	.	.	.	.	105	15
Nov. 1 .	.	.	.	.	55	.	16	130	15	.	86	130
" 8 .	12	22	.	.	45	.	20	135	20	10	97	167
" 15 .	.	.	.	.	35	.	27	153	10	5	72	158
" 22 .	4	9	.	.	30	.	.	.	20	.	54	9
" 29 .	.	.	.	.	20	.	.	.	.	.	20	.
Dec. 6 .	.	.	.	.	15	.	.	.	.	.	15	.
" 13 .	.	.	.	.	.	.	.	.	.	.	.	.
" 20 .	.	.	.	.	.	.	.	.	.	.	.	.
" 27 .	.	.	.	.	.	.	.	.	.	.	.	.
1874.												
Jan. 3 .	.	.	.	.	.	.	.	.	.	.	.	.
" 10 .	.	.	.	.	.	.	.	.	.	.	.	.
" 17 .	.	.	.	.	.	.	.	.	.	.	.	.
" 24 .	.	.	.	.	.	.	.	.	.	.	.	.
" 31 .	.	.	.	.	.	.	.	.	.	.	.	.
Winter & Spring.	?	4890	.	.	.	.	.	.	.	.	.	.
May 23 .	?	99	.	.	.	.	.	.	.	.	?	99
" 30 .	57	66	.	.	.	.	.	.	.	.	57	66
June 6 .	68	112	.	106	92	80	.	.	.	.	160	298
" 13 .	67	135	50	136	99	75	13	17	.	.	229	363
" 20 .	64	220	107	426	116	345	38	127	.	.	325	1118
" 27 .	68	400	134	590	148	215	37	228	.	.	387	1433
July 4 .	69	108	154	481	185	260	29	41	.	.	437	890
" 11 .	68	309	288	1584	192	465	25	50	.	.	573	2408
" 18 .	69	217	274	1666	233	275	45	94	80	210	701	2462
" 25 .	57	202	357	879	209	137	42	76	83	96	748	1390
Aug. 1 .	41	227	302	653	200	228	40	77	126	297	709	1482
" 8 .	41	278	431	676	238	211	36	132	123	497	869	1794
" 15 .	16	367	287	573	193	98	33	160	72	76	601	1274
" 22 .	15	338	350	2109	208	307	20	174	164	338	757	3266
" 29 .	37	381	164	361	209	301	25	230	182	309	617	1582
Sept. 5 .	2	1	180	919	97	206	10	46	65	126	354	1298
" 12 .	.	.	260	526	188	368	34	167	72	200	554	1261
" 19 .	.	.	280	1423	134	369	33	101	114	293	561	2186
" 26 .	.	.	151	208	134	359	31	125	145	344	461	1036

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1874.												
Oct. 3	.	.	230	45	124	218	.	.	100	116	454	379
" 10	.	.	90	11	85	30	.	.	20	8	195	49
" 17	.	.	120	500	37	55	.	.	30	60	187	615
" 24	.	.	250	70	28	17	.	.	12	10	290	97
" 31	.	.	48	841	16	170	.	.	60	140	124	1151
Nov. 7	.	.	44	350	.	.	.	.	40	100	84	450
" 14	.	.	88	267	10	2	.	.	.	.	98	269
" 21	.	.	.	.	4	15	.	.	.	.	4	15
" 28	.	.	.	.	.	.	.	.	.	.	.	.
Dec. 5	.	.	.	.	.	.	.	.	.	.	.	.
" 12	.	.	.	.	.	.	.	.	.	.	.	.
" 19	.	.	.	.	.	.	.	.	.	.	.	.
" 26	.	.	.	.	.	.	.	.	.	.	.	.
1875.												
Jan. 2	.	.	.	.	.	.	.	.	.	.	.	.
" 9	.	.	.	.	.	.	.	.	.	.	.	.
" 16	.	.	.	.	.	.	.	.	.	.	.	.
" 23	.	.	.	.	2	4	.	.	.	.	2	4
" 30	.	.	.	.	4	6	.	.	.	.	4	6
Winter & Spring.	?	9197	.	.	.	.	.	.	.	.	.	.
May 22	37	28	.	.	.	.	.	.	.	.	37	28
" 29	47	22	.	.	.	.	.	.	.	.	47	22
June 5	53	6	?	58	70	95	.	.	.	.	123	159
" 12	46	2	55	39	77	80	.	.	.	.	178	121
" 19	27	2	110	90	106	225	.	.	.	.	243	317
" 26	38	3	160	308	106	250	.	.	.	.	304	561
July 3	30	19	140	204	121	340	.	.	.	.	291	563
" 10	42	59	166	257	196	1005	?	30	65	60	469	1411
" 17	43	20	115	215	225	1635	33	28	110	143	526	2021
" 24	43	53	82	118	230	1020	17	30	133	123	505	1344
" 31	51	67	52	323	219	1675	19	105	116	207	457	2377
Aug. 7	58	116	178	606	210	1850	24	144	95	392	565	3108
" 14	34	33	150	188	200	630	27	103	54	172	465	1126
" 21	30	52	74	132	220	915	30	100	80	290	434	1489
" 28	20	20	84	160	235	674	22	71	35	53	396	978
Sept. 4	12	20	94	116	208	203	22	36	70	51	406	426
" 11	6	10	82	172	188	128	25	45	40	40	341	395
" 18	.	.	29	70	120	15	.	.	6	3	155	88
" 25	.	.	14	7	62	32	.	.	4	.	80	39
Oct. 2	.	.	.	.	114	47	.	.	.	.	114	47
" 9	.	.	14	2	110	117	.	.	.	.	124	119
" 16	.	.	.	.	126	525	.	.	76	82	202	607
" 23	.	.	.	.	130	35	.	.	30	20	160	50
" 30	.	.	.	.	166	525	.	.	35	35	201	560



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1875.												
Nov. 6 .	.	.	.	.	188	910	.	.	31	286	219	1196
" 13 .	.	.	.	.	93	110	.	.	120	130	213	240
" 20 .	.	.	.	.	96	165	.	.	80	90	176	255
" 27 .	.	.	.	.	80	30	.	.	15	.	95	30
Dec. 4 .	.	.	.	.	65	115	.	.	.	.	65	115
" 11 .	.	.	.	.	106	90	.	.	.	.	106	90
" 18 .	.	.	.	.	70	90	.	.	.	.	70	90
" 25 .	.	.	.	.	.	.	.	.	.	.	.	.
" 31 .	.	.	.	.	10	5	.	.	.	.	10	5
1876.												
Jan. 1 .	.	.	.	.	.	.	.	.	.	.	.	.
" 8 .	.	.	.	.	.	.	.	.	.	.	.	.
" 15 .	.	.	.	.	6	30	.	.	.	.	6	30
" 22 .	.	.	.	.	4	.	.	.	.	.	4	.
" 29 .	.	.	.	.	.	.	.	.	.	.	.	.
Winter & Spring.	?	6071	.	.	.	.	.	.	.	.	.	.
May 13 .	26	43	.	.	.	.	.	.	.	.	26	43
" 20 .	59	75	.	.	.	.	.	.	.	.	59	75
" 27 .	65	48	.	.	.	.	.	.	.	.	65	48
June 3 .	67	62	?	9	74	48	.	.	.	.	141	119
" 10 .	71	310	33	41	79	303	.	.	.	.	183	654
" 17 .	71	255	108	249	88	262	?	*79	.	.	267	766
" 24 .	72	136	104	82	103	162	33	92	.	.	312	472
July 1 .	73	156	185	352	118	400	45	91	.	.	421	999
" 8 .	73	176	141	239	176	445	42	67	60	75	492	1002
" 15 .	73	156	140	416	170	1270	38	108	46	75	467	2025
" 22 .	59	115	130	305	180	910	40	129	70	144	479	1603
" 29 .	57	105	146	729	200	2095	41	62	65	128	509	3119
Aug. 5 .	54	89	186	1363	159	1222	34	95	47	151	480	2920
" 12 .	32	162	186	946	162	1450	38	358	71	306	489	3222
" 19 .	30	47	143	577	183	609	35	109	80	318	471	1660
" 26 .	18	9	114	452	200	350	40	71	79	152	451	1034
Sept. 2 .	24	25	195	422	200	546	39	124	95	229	553	1346
" 9 .	10	17	210	594	200	622	22	41	143	460	585	1734
" 16 .	.	.	190	166	200	378	19	25	96	269	505	838
" 23 .	.	.	148	223	208	429	3	16	128	297	487	965
" 30 .	.	.	233	90	248	557	15	33	145	409	641	1089
Oct. 7 .	5	10	9	20	245	436	2	17	80	90	341	573
" 14 .	8	7	.	.	250	520	.	.	56	135	314	662
" 21 .	4	2	.	.	210	989	.	.	40	190	254	1181
" 28 .	.	.	.	.	420	5300	.	.	47	436	467	5736
Nov. 4 .	.	.	.	.	300	900	.	.	110	253	410	1153
" 11 .	.	.	.	.	186	1758	.	.	78	489	264	2247
" 18 .	.	.	.	.	82	158	.	.	5	30	87	188
" 25 .	.	.	.	.	100	70	.	.	110	166	210	236

\* From 1st June.



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued.*

Week ended		Ballantrae.		Campbelltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1876.													
Dec.	2	.	.	.	.	46	617	.	.	90	158	136	775
"	9	.	.	.	.	60	.	.	.	5	2	65	2
"	16	.	.	.	.	10	.	.	.	.	.	10	.
"	23	.	.	.	.	.	.	.	.	.	.	.	.
"	30	.	.	.	.	.	.	.	.	.	.	.	.
1877.													
Jan.	6	.	.	.	.	.	.	.	.	.	.	.	.
"	13	.	.	.	.	.	.	.	.	.	.	.	.
"	20	.	.	.	.	.	.	.	.	.	.	.	.
"	27	.	.	.	.	2	.	.	.	.	.	2	.
Winter & Spring.		?	10254	.	.	.	.	.	.	.	.	.	10254
May	12	37	81	.	.	.	.	.	.	.	.	37	81
"	19	57	57	.	.	.	.	.	.	.	.	57	57
"	26	70	157	.	.	.	.	.	.	.	.	70	157
June	2	73	203	?	5	.	.	.	.	.	.	73	208
"	9	59	134	26	5	73	24	?	72	.	.	158	235
"	16	79	113	89	354	75	1284	33	73	.	.	276	1824
"	23	81	111	119	512	103	706	39	37	.	.	342	1366
"	30	44	75	117	292	141	600	38	52	18	14	358	1033
July	7	55	216	120	395	167	1254	45	132	29	60	416	2057
"	14	70	94	109	450	195	897	41	57	51	73	466	1571
"	21	56	128	100	1270	201	1265	34	92	85	154	476	2909
"	28	57	183	128	1502	242	702	34	120	45	120	506	2627
Aug.	4	38	212	138	1988	412	1109	32	211	46	203	666	3723
"	11	12	29	132	2109	442	1735	36	172	68	339	690	4384
"	18	24	40	84	866	214	1110	36	142	118	380	476	2538
"	25	35	87	109	657	304	423	41	105	64	266	553	1538
Sept.	1	4	13	82	516	400	1053	29	80	104	258	619	1920
"	8	.	.	133	294	344	1371	13	21	70	219	560	1905
"	15	.	.	64	46	217	202	8	15	35	20	324	283
"	22	.	.	95	410	287	697	12	70	50	120	444	1297
"	29	.	.	89	368	286	2099	14	42	13	49	402	2558
Oct.	6	.	.	61	42	292	1587	6	9	104	437	463	2075
"	13	-2	10	.	.	376	210	.	.	12	3	390	223
"	20	.	.	.	.	266	240	.	.	35	40	301	280
"	27	.	.	.	.	134	180	.	.	.	.	134	180
Nov.	3	.	.	.	.	70	660	.	.	22	491	99	1151
"	10	.	.	.	.	7	60	.	.	30	30	37	90
"	17	.	.	.	.	48	150	.	.	.	.	48	150
"	24	.	.	.	.	82	.	.	.	.	.	82	.
Dec.	1	.	.	.	.	70	.	.	.	60	392	142	392
"	8	.	.	.	.	78	.	.	.	15	5	85	5
"	15	.	.	.	.	10	.	.	.	.	.	10	.</

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1878.													
Jan.	5 .	31	95	.	.	.	.	.	.	.	.	31	95
"	12 .	48	230	.	.	.	.	.	.	.	.	48	230
"	19 .	83	751	.	.	.	.	.	.	.	.	83	751
"	26 .	73	174	.	.	.	.	.	.	.	.	73	174
Feb.	2 .	151	3820	.	.	.	.	.	.	.	.	151	3820
"	9 .	165	4462	.	.	.	.	.	.	.	.	165	4462
"	16 .	154	206	.	.	.	.	.	.	.	.	154	206
"	23 .	191	1690	.	.	.	.	.	.	.	.	191	1690
March	2 .	182	4600	.	.	.	.	.	.	.	.	182	4600
"	9 .	182	22	.	.	.	.	.	.	.	.	182	22
"	16 .	182	1261	.	.	.	.	.	.	.	.	182	1261
"	23 .	178	474	.	.	.	.	.	.	.	.	178	474
"	30 .	35	22	.	.	.	.	.	.	.	.	35	22
April	6 .	15	23	.	.	.	.	.	.	.	.	15	23
"	13 .	.	.	.	.	.	.	.	.	.	.	.	.
"	20 .	.	.	.	.	.	.	.	.	.	.	.	.
"	27 .	.	.	.	.	.	.	.	.	.	.	.	.
May	4 .	.	.	.	.	.	.	.	.	.	.	.	.
"	11 .	18	20	.	.	.	.	.	.	.	.	18	20
"	18 .	37	25	.	.	.	.	.	.	.	.	37	25
"	25 .	57	50	?	*800	.	.	?	24	.	.	57	74
June	1 .	71	145	.	.	.	.	26	40	.	.	97	185
"	8 .	80	73	64	206	87	207	27	26	.	.	258	512
"	15 .	84	99	107	793	112	322	26	22	.	.	329	1236
"	22 .	84	58	152	293	104	480	26	30	.	.	366	861
"	29 .	79	97	183	835	138	335	18	10	?	+25	418	1277
July	6 .	75	202	241	360	141	650	20	21	15	23	492	1256
"	13 .	77	116	163	1508	154	1100	23	76	46	122	463	2922
"	20 .	45	46	183	1443	150	1465	26	64	88	210	492	3228
"	27 .	.	.	153	550	145	670	28	70	60	73	386	1363
Aug.	3 .	.	.	299	903	133	972	25	47	56	17	513	1939
"	10 .	.	.	180	255	139	115	17	25	76	45	412	440
"	17 .	.	.	149	289	188	47	25	104	69	119	431	559
"	24 .	.	.	169	290	126	80	24	29	115	196	434	595
"	31 .	.	.	152	268	123	57	15	17	20	9	310	351
Sept.	7 .	.	.	86	279	125	55	3	3	5	2	219	339
"	14 .	.	.	32	13	144	37	.	.	34	14	210	64
"	21 .	.	.	.	.	5	.	.	.	4	2	9	2
"	28 .	.	.	.	.	40	4	.	.	.	.	40	4
Oct.	5 .	.	.	.	.	.	.	.	.	.	.	.	.
"	12 .	.	.	.	.	.	.	.	.	.	.	.	.
"	19 .	.	.	.	.	12	14	.	.	.	.	12	14
"	26 .	.	.	.	.	24	10	.	.	.	.	24	10

\* April and May.

† For June.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1878.												
Nov. 2 .	.	.	.	.	6	.	.	.	.	.	6	.
" 9 .	.	.	.	.	50	1240	.	.	17	83	67	1323
" 16 .	.	.	.	.	50	350	.	.	12	20	62	370
" 23 .	.	.	.	.	105	300	.	.	14	15	119	315
" 30 .	10	30	.	.	100	250	.	.	.	.	110	280
Dec. 7 .	14	9	.	.	90	100	.	.	.	.	104	109
" 14 .	.	.	.	.	8	30	.	.	6	36	14	66
" 21 .	7	5	.	.	.	.	.	.	2	26	9	31
" 28 .	.	.	.	.	.	.	.	.	.	.	.	.
1879.												
Jan. 4 .	.	.	.	.	.	.	.	.	.	.	.	.
" 11 .	56	90	.	.	.	.	.	.	.	.	56	90
" 18 .	188	1334	.	.	.	.	.	.	.	.	188	1334
" 25 .	290	3078	.	.	.	.	.	.	.	.	290	3078
Feb. 1 .	304	3428	.	.	.	.	.	.	.	.	304	3428
" 8 .	304	104	.	.	.	.	.	.	.	.	304	104
" 15 .	125	410	.	.	.	.	.	.	.	.	125	410
" 22 .	251	1755	.	.	.	.	.	.	.	.	251	1755
March 1 .	251	4007	.	.	.	.	.	.	.	.	251	4007
" 8 .	204	1220	.	.	.	.	.	.	.	.	204	1220
" 15 .	210	921	.	.	.	.	.	.	.	.	210	921
" 22 .	199	1783	.	.	.	.	.	.	.	.	199	1783
" 29 .	98	1050	.	.	.	.	.	.	.	.	98	1050
April 5 .	47	433	.	.	.	.	.	.	.	.	47	433
" 12 .	10	21	.	.	.	.	.	.	.	.	10	21
" 19 .	.	.	.	.	.	.	.	.	.	.	.	.
" 26 .	.	.	.	.	.	.	.	.	.	.	.	.
May 3 .	13	458	.	.	.	.	.	.	.	.	13	458
" 10 .	37	38	.	.	.	.	.	.	.	.	37	38
" 17 .	?	14	.	.	.	.	.	.	.	.	?	14
" 24 .	53	34	?	3200	.	.	.	.	.	.	53	34
" 31 .	71	127	94	276	.	.	.	.	.	.	165	403
June 7 .	76	59	115	218	92	393	.	.	.	.	283	670
" 14 .	80	76	117	539	92	785	.	.	.	.	289	1400
" 21 .	71	58	192	139	103	275	.	.	.	.	366	472
" 28 .	85	150	236	231	116	715	?	+98	63	92	500	1188
July 5 .	?	121	214	261	137	814	48	149	95	160	494	1505
" 12 .	?	100	225	1234	149	765	45	57	66	135	485	2291
" 19 .	83	118	127	1025	169	980	50	135	113	238	542	2496
" 26 .	56	124	183	1315	159	1109	44	99	76	178	518	2825
Aug. 2 .	56	117	163	1296	169	2076	50	166	96	244	534	3899
" 9 .	37	136	191	1924	206	1523	46	210	106	550	586	4343
" 16 .	49	116	164	829	184	2951	48	117	102	254	547	4267
" 23 .	62	124	116	443	182	1963	46	85	94	155	500	2770
" 30 .	50	39	113	585	174	972	34	89	85	143	456	1828

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued*.

Week ended		Ballantrae.		Campbelltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1879.													
Sept.	6	50	62	142	971	181	1304	18	75	69	454	460	2866
"	13	.	.	155	944	149	536	29	63	40	102	373	1645
"	20	.	.	191	1254	131	726	26	115	18	129	366	2224
"	27	.	.	155	1003	165	239	21	48	40	75	381	1365
Oct.	4	?	26	202	887	142	201	18	74	48	210	410	1398
"	11	17	36	94	318	179	785	.	.	86	204	376	1343
"	18	.	.	129	2949	134	840	.	.	104	400	367	4189
"	25	22	57	180	2985	120	410	.	.	36	28	358	3480
Nov.	1	24	68	265	1507	110	160	.	.	148	933	547	2668
"	8	.	.	560	3889	87	448	.	.	37	287	684	4624
"	15	15	10	564	2067	24	70	.	.	175	370	778	2517
"	22	.	.	530	1515	.	.	.	.	96	305	626	1820
"	29	.	.	162	55	5	5	.	.	160	210	327	270
Dec.	6	.	.	110	46	.	.	.	.	37	18	147	64
"	13	46	288	82	75	.	.	.	.	.	.	128	363
"	20	186	2722	.	.	.	.	.	.	.	.	186	2722
"	27	202	1075	.	.	.	.	.	.	.	.	202	1075
1880.													
Jan.	3	.	.	.	.	.	.	.	.	.	.	.	.
"	10	290	499	.	.	.	.	.	.	.	.	290	499
"	17	310	2053	.	.	.	.	.	.	.	.	310	2053
"	24	364	2624	.	.	.	.	.	.	.	.	364	2624
"	31	19	24	.	.	.	.	.	.	.	.	19	24
Feb.	7	307	2928	.	.	.	.	.	.	.	.	307	2928
"	14	210	512	.	.	.	.	.	.	.	.	210	512
"	21	185	558	.	.	.	.	.	.	.	.	185	558
"	28	302	2520	.	.	.	.	.	.	.	.	302	2520
March	6	127	829	.	.	.	.	.	.	.	.	127	829
"	13	253	4806	.	.	.	.	.	.	.	.	253	4806
"	20	267	4231	.	.	.	.	.	.	.	.	267	4231
"	27	?	9586	.	.	.	.	.	.	.	.	?	9586
April	3	10	.	.	.	.	.	.	.	.	.	10	.
"	10	.	.	.	.	.	.	.	.	.	.	.	.
"	17	.	.	.	.	.	.	.	.	.	.	.	.
"	24	.	.	.	.	.	.	.	.	.	.	.	.
May	1	.	.	.	.	.	.	.	.	.	.	.	.
"	8	.	.	.	.	.	.	.	.	.	.	.	.
"	15	.	.	.	.	.	.	.	.	.	.	.	.
"	22	47	20	?	*5090	.	.	.	.	.	.	47	20
"	29	60	179	123	30	.	.	.	.	.	.	183	209
June	5	95	275	145	135	96	945	.	.	.	.	336	1355
"	12	102	430	186	487	94	190	.	.	.	.	382	1107
"	19	124	335	236	358	101	340	?	+86	?	*40	461	1033
"	26	126	399	303	1350	114	342	70	174	75	136	688	2401

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued.*

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1880.													
July	3	140	1400	345	2700	125	620	78	370	88	222	776	5312
"	10	113	568	348	3308	122	2650	35	275	148	1118	766	7919
"	17	146	294	182	1767	150	1435	44	316	90	1196	612	5008
"	24	105	210	190	2044	130	1611	42	193	176	429	643	4487
"	31	39	111	192	2254	166	1202	61	235	207	738	665	4540
Aug.	7	82	152	210	2822	230	1540	54	161	156	1097	732	5772
"	14	44	111	239	2184	151	704	48	182	139	316	621	3497
"	21	41	57	176	168	179	618	22	40	89	77	507	960
"	28	26	13	122	252	175	1060	21	28	100	148	444	1501
Sept.	4	38	15	25	421	219	520	14	35	90	82	386	1073
"	11	20	10	207	258	188	320	1	1	10	3	426	592
"	18	.	.	148	128	154	268	8	21	55	36	365	453
"	25	.	.	299	1052	180	844	.	.	46	75	525	1971
Oct.	2	?	18	318	720	154	487	.	.	47	52	519	1277
"	9	13	17	333	220	130	440	.	.	42	65	518	742
"	16	.	.	408	63	123	480	.	.	105	356	636	899
"	23	25	16	380	1220	96	280	.	.	66	304	567	1820
"	30	32	83	302	1081	124	220	.	.	55	130	513	1514
Nov.	6	62	125	430	1210	172	890	.	.	333	1274	997	3499
"	13	90	175	230	269	200	1820	.	.	102	409	622	2673
"	20	195	420	162	1146	338	1350	.	.	45	188	740	3104
"	27	131	27	54	.	218	510	.	.	47	85	450	622
Dec.	4	171	910	242	1789	220	650	.	.	69	122	702	3471
"	11	?	40	108	939	210	420	.	.	56	129	374	1528
"	18	130	20	110	1540	8	12	.	.	13	2	261	1574
"	25	.	.	105	515	.	.	.	.	.	.	105	515
1881.													
Jan.	1	.	.	.	.	.	.	.	.	.	.	.	.
"	8	290	2125	.	.	.	.	.	.	.	.	290	2125
"	15	158	62	.	.	.	.	.	.	.	.	158	62
"	22	407	120	.	.	.	.	.	.	.	.	407	120
"	29	345	565	.	.	.	.	.	.	.	.	345	565
Feb.	5	335	793	.	.	.	.	.	.	.	.	335	793
"	12	255	237	.	.	.	.	.	.	.	.	255	237
"	19	297	2740	.	.	.	.	.	.	.	.	297	2740
"	26	315	5540	.	.	.	.	.	.	.	.	315	5540
March	5	256	452	.	.	.	.	.	.	.	.	256	452
"	12	158	1562	.	.	.	.	.	.	.	.	158	1562
"	19	180	1489	.	.	.	.	.	.	.	.	180	1489
"	26	?	8419	.	.	.	.	.	.	.	.	?	8419
April	2	12	.	.	.	.	.	.	.	.	.	12	.
"	9	.	.	.	.	.	.	.	.	.	.	.	.
"	16	.	.	.	.	.	.	.	.	.	.	.	.
"	23	.	.	.	.	.	.	.	.	.	.	.	.
"	30	.	.	.	.	.	.	.	.	.	.	.	.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1881.													
May	7	.	.	.	.	.	.	.	.	.	.	.	.
"	14	.	.	.	.	.	.	.	.	.	.	.	.
"	21	.	.	.	.	.	.	.	.	.	.	.	.
"	28	.	.	?	*1280	.	.	.	.	.	.	.	.
June	4	95	231	152	147	82	342	.	.	.	.	329	720
"	11	68	32	208	607	103	1580	.	.	.	.	379	2219
"	18	102	45	276	872	172	1165	.	.	.	.	550	2082
"	25	97	54	304	441	260	710	.	.	.	.	659	1205
July	2	121	287	250	1311	244	1135	?	132†	.	.	615	2733
"	9	78	220	269	1645	274	360	53	204	.	.	674	2429
"	16	117	212	316	1764	187	186	40	101	.	.	660	2263
"	23	100	110	330	1660	177	2811	40	52	99	81	746	4714
"	30	73	80	334	1530	236	2536	33	75	98	183	774	4404
Aug.	6	33	33	369	1092	224	2344	33	85	14	5	673	3559
"	13	42	91	335	1136	170	1968	37	76	98	202	682	3473
"	20	75	158	72	822	194	3903	21	180	135	612	497	5675
"	27	26	4	390	917	196	1331	30	122	10	13	652	2587
Sept.	3	.	.	321	749	181	1440	9	55	5	10	516	2254
"	10	.	.	252	113	144	1121	7	10	10	12	413	1256
"	17	.	.	248	52	135	1035	2	36	.	.	385	1123
"	24	.	.	40	56	119	883	2	42	.	.	161	981
Oct.	1	.	.	40	78	118	700	3	44	.	.	161	822
"	8	.	.	43	16	107	60	.	.	.	.	150	76
"	15	.	.	60	.	104	226	.	.	.	.	164	226
"	22	.	.	50	2	66	212	.	.	.	.	71	214
"	29	.	.	87	422	130	1750	.	.	.	.	217	2172
Nov.	5	34	6	84	64	154	1530	.	.	15	20	287	1620
"	12	32	5	134	376	194	600	.	.	7	55	367	1036
"	19	20	.	80	269	160	700	.	.	12	95	272	1064
"	26	.	.	70	334	150	960	.	.	9	22	229	1316
Dec.	3	.	.	84	224	160	870	.	.	9	7	253	1101
"	10	31	7	100	766	164	400	.	.	19	61	314	1234
"	17	46	10	125	1588	152	85	.	.	.	.	323	1683
"	24	75	67	48	60	.	.	.	.	.	.	123	127
"	31	121	94	.	.	.	.	.	.	.	.	121	94
1882.													
Jan.	7	108	.	.	.	.	.	.	.	.	.	108	.
"	14	184	10	.	.	.	.	.	.	.	.	184	10
"	21	226	790	.	.	.	.	.	.	.	.	226	790
"	28	236	383	.	.	.	.	.	.	.	.	236	383
Feb.	4	403	1726	.	.	.	.	.	.	.	.	403	1726
"	11	402	1358	.	.	.	.	.	.	.	.	402	1358
"	18	.	.	.	.	.	.	.	.	.	.	.	.
"	25	422	3104	.	.	.	.	.	.	.	.	422	3104

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued*.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1882.													
March	4 .	378	1286	.	.	.	.	.	.	.	.	378	1286
"	11 .	55	51	.	.	.	.	.	.	.	.	55	51
"	18 .	.	.	.	.	.	.	.	.	.	.	.	.
"	25 .	.	.	.	.	.	.	.	.	.	.	.	.
April	1 .	?	125	.	.	.	.	.	.	.	.	.	.
"	8 .			.	.	.	.	.	.	.	.	.	.
"	15 .			.	.	.	.	.	.	.	.	.	.
"	22 .			.	.	.	.	.	.	.	.	.	.
"	29 .	.	.	.	.	.	.	.	.	.	.	.	.
May	6 .	30	46	.	.	.	.	.	.	.	.	30	46
"	13 .	45	34	.	.	.	.	.	.	.	.	45	34
"	20 .	45	27	.	.	.	.	.	.	.	.	45	27
"	27 .	58	20	?	*2249	.	.	.	.	.	.	58	20
June	3 .	109	83	186	†445	42	23	.	.	.	.	337	551
"	10 .	147	242	356	932	84	10	.	.	.	.	587	1184
"	17 .	148	152	390	1189	99	45	?	‡37	.	.	637	1386
"	24 .	176	234	487	2807	190	664	57	168	.	.	910	3873
July	1 .	123	132	570	1956	205	2843	42	79	.	.	940	5010
"	8 .	52	52	422	2502	214	1719	33	136	?	§350	721	4409
"	15 .	45	69	610	3604	214	1784	34	264	278	350	1181	6071
"	22 .	47	88	340	2537	277	1990	39	210	94	431	797	5256
"	29 .	40	59	420	3772	357	2367	22	61	12	8	851	6267
Aug.	5 .	8	50	383	2179	241	1780	24	72	43	206	699	4287
"	12 .	6	32	351	2545	185	3454	40	415	52	97	634	6543
"	19 .	14	24	326	2449	184	3370	45	271	51	114	620	6228
"	26 .	11	9	321	2878	140	2961	39	613	46	118	557	6579
Sept.	2 .	12	73	315	306	159	313	34	221	5	6	525	919
"	9 .	12	55	310	1670	203	2170	51	374	8	15	584	4284
"	16 .	11	13	156	2740	188	2502	21	188	4	5	380	5448
"	23 .	9	51	158	500	198	2656	24	389	.	.	389	3596
"	30 .	8	49	140	429	201	992	23	214	60	150	432	1834
Oct.	7 .	17	29	126	1086	207	2320	8	22	85	215	443	3672
"	14 .	3	.	110	957	214	2894	.	.	58	226	385	4077
"	21 .	4	41	110	1085	243	2209	.	.	68	180	425	3515
"	28 .	21	11	116	2792	249	5240	.	.	130	930	516	9143
Nov.	4 .	9	156	40	.	251	2640	.	.	145	437	445	3233
"	11 .	12	6	40	.	255	3568	.	.	140	490	447	4064
"	18 .	.	.	.	.	244	2205	.	.	130	330	374	2535
"	25 .	.	.	.	.	252	2327	.	.	60	165	312	2492
Dec.	2 .	.	.	.	.	209	684	.	.	63	229	272	913
"	9 .	2	2	40	.	40	18	.	.	18	25	100	45
"	16 .	21	15	.	.	16	6	.	.	.	.	37	21
"	23 .	70	32	.	.	.	.	.	.	.	.	70	32
"	30 .	93	67	.	.	.	.	.	.	.	.	93	67

\* From 1st January to 31st May.

† 1st to 3rd June.

‡ Up to date.

§ From 1st January.



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued.*

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1883.													
Jan.	6	98	585	.	.	.	.	.	.	.	.	98	585
"	13	182	796	.	.	.	.	.	.	.	.	182	796
"	20	330	2196	.	.	.	.	.	.	.	.	330	2196
"	27	246	120	.	.	.	.	.	.	.	.	246	120
Feb.	3	262	87	.	.	.	.	.	.	.	.	262	87
"	10	132	327	.	.	.	.	.	.	.	.	132	327
"	17	10	19	.	.	.	.	.	.	.	.	10	19
"	24	408	1333	.	.	.	.	.	.	.	.	408	1333
Mar.	3	320	16060	.	.	.	.	.	.	.	.	320	16060
"	10	130	774	.	.	.	.	.	.	.	.	130	774
"	17	48	339	.	.	.	.	.	.	.	.	48	339
"	24	57	393	.	.	.	.	.	.	.	.	57	393
"	31	.	.	.	.	.	.	.	.	.	.	.	.
April	7	.	.	.	.	.	.	.	.	.	.	.	.
"	14	.	.	.	.	.	.	.	.	.	.	.	.
"	21	.	.	.	.	.	.	.	.	.	.	.	.
"	28	.	.	.	.	.	.	.	.	.	.	.	.
May	5	7	5	.	.	.	.	.	.	.	.	7	5
"	12	13	3	.	.	.	.	.	.	.	.	13	3
"	19	69	49	.	.	.	.	.	.	.	.	69	49
"	25	102	135	.	.	.	.	.	.	.	.	102	135
June	2	131	207	?	*1859	.	.	.	.	.	.	131	207
"	9	176	327	210	624	150	6	.	.	.	.	536	957
"	16	149	167	409	620	152	208	.	.	.	.	710	995
"	23	127	112	4	9	982	207	1435	?	†71	.	743	2529
"	30	101	172	340	1041	261	1655	34	78	.	.	736	2946
July	7	102	187	356	934	250	1594	22	56	.	.	730	2771
"	14	112	229	362	1573	254	2820	32	196	?	*410	760	4818
"	21	77	41	336	1348	240	1977	21	111	149	236	823	3713
"	28	50	34	368	2125	213	2074	33	90	27	69	691	4392
Aug.	4	9	14	428	2932	206	2427	28	84	53	95	724	5552
"	11	55	27	326	928	201	1082	14	36	45	4	641	2077
"	18	19	32	339	1431	192	1384	7	90	6	2	563	2939
"	25	42	58	431	1010	224	1052	17	75	16	145	730	2340
Sept.	1	.	.	325	1394	209	1692	31	246	10	40	575	3372
"	8	6	8	332	1460	199	1936	19	102	10	46	566	3553
"	15	23	11	191	716	189	2173	27	227	10	87	440	3214
"	22	12	2	112	159	207	1506	7	57	10	.	348	1724
"	29	.	.	113	977	206	1743	.	.	4	3	323	2723
Oct.	6	.	.	119	3864	234	3647	.	.	60	120	413	7631
"	13	.	.	122	1624	215	2252	.	.	46	110	383	3986
"	20	.	.	124	617	204	8	.	.	30	65	358	690
"	27	.	.	121	1017	196	906	.	.	22	48	339	1971

\* From 1st January.

† Up to date.



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued*.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1883.													
Nov.	3	.	.	142	3505	209	1158	.	.	65	135	416	4798
"	10	.	.	155	738	180	826	.	.	76	105	411	1669
"	17	.	.	175	1310	164	165	.	.	60	112	399	1587
"	24	.	.	79	135	120	38	.	.	30	20	229	193
Dec.	1	2	9	195	63	90	333	.	.	45	112	332	517
"	8	17	33	112	1479	45	12	.	.	65	42	239	1566
"	15	8	8	.	.	.	.	.	.	.	.	8	8
"	22	48	55	20	.	.	.	.	.	.	.	68	55
"	29	89	47	.	.	.	.	.	.	.	.	89	47
1884.													
Jan.	5	90	182	.	.	.	.	.	.	.	.	90	182
"	12	76	35	.	.	.	.	.	.	.	.	76	35
"	19	246	2271	.	.	.	.	.	.	.	.	246	2271
"	26	117	255	.	.	.	.	.	.	.	.	117	255
Feb.	2	70	70	.	.	.	.	.	.	.	.	70	70
"	9	222	559	.	.	.	.	.	.	.	.	222	559
"	16	255	1067	.	.	.	.	.	.	.	.	255	1067
"	23	245	2063	.	.	.	.	.	.	.	.	245	2063
March	1	257	4776	.	.	.	.	.	.	.	.	257	4776
"	8	198	1802	.	.	.	.	.	.	.	.	198	1802
"	15	71	238	.	.	.	.	.	.	.	.	71	238
"	22	82	188	.	.	.	.	.	.	.	.	82	188
"	29	72	1052	.	.	.	.	.	.	.	.	72	1052
April	5	40	6	.	.	.	.	.	.	.	.	40	6
"	12	.	.	.	.	.	.	.	.	.	.	.	.
"	19	.	.	.	.	.	.	.	.	.	.	.	.
"	26	.	.	.	.	.	.	.	.	.	.	.	.
May	3	.	.	.	.	.	.	.	.	.	.	.	.
"	10	49	21	.	.	.	.	.	.	.	.	49	21
"	17	76	116	.	.	.	.	.	.	.	.	76	116
"	23	107	279	.	.	.	.	.	.	.	.	107	279
"	31	125	93	?	*1706	.	.	.	.	.	.	125	93
June	7	98	102	143	368	149	1060	.	.	.	.	390	1530
"	14	122	339	205	232	235	480	?	+87	.	.	562	1051
"	21	141	199	316	811	233	1244	22	28	.	.	712	2282
"	28	150	326	420	952	238	1284	28	49	.	.	836	2611
July	5	113	171	390	623	258	1086	36	108	?	*552	797	1988
"	12	119	238	330	775	284	990	19	104	134	240	886	2347
"	19	68	202	370	1432	250	490	68	159	140	190	896	2473
"	26	38	105	348	3150	227	1186	37	134	56	166	706	4741
Aug.	2	38	89	428	2692	184	609	41	284	76	230	767	3904
"	9	43	306	398	871	216	1288	26	286	79	178	762	2930
"	16	52	66	280	1651	208	860	49	331	108	653	697	3561
"	23	44	92	270	1648	190	1546	32	136	106	286	642	3708
"	30	28	26	204	1629	206	1310	45	144	67	176	550	3285

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbelltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1884.													
Sept.	6 .	10	26	172	40	177	248	44	69	81	187	484	570
"	13 .	21	53	179	269	188	597	35	89	63	134	486	1142
"	20 .	.	.	142	295	184	792	15	8	32	19	373	1114
"	27 .	.	.	142	321	188	80	.	.	10	.	340	401
Oct.	4 .	?	9	150	321	190	63	.	.	10	10	350	403
"	11 .	4	9	22	806	164	456	.	.	128	149	318	1420
"	18 .	6	82	244	3929	170	69	.	.	131	590	551	4670
"	25 .	6	66	266	4578	134	14	.	.	84	90	490	4748
Nov.	1 .	.	.	266	20	113	4	.	.	75	35	454	59
"	8 .	.	.	120	812	.	.	.	.	63	50	183	862
"	15 .	.	.	195	3006	34	.	.	.	54	95	283	3101
"	22 .	26	196	126	410	30	.	.	.	76	185	258	791
"	29 .	8	132	46	165	26	.	.	.	82	101	162	398
Dec.	6 .	.	.	.	.	.	.	.	.	4	5	4	5
"	13 .	16	87	.	.	.	.	.	.	.	.	16	87
"	20 .	.	.	.	.	.	.	.	.	.	.	.	.
"	27 .	66	329	.	.	.	.	.	.	40	240	106	569
1885.													
Jan.	3 .	6	99	.	.	.	.	.	.	.	.	6	99
"	10 .	.	.	.	.	.	.	.	.	.	.	.	.
"	17 .	94	34	.	.	.	.	.	.	.	.	94	34
"	24 .	128	530	.	.	.	.	.	.	.	.	128	530
"	31 .	84	81	.	.	.	.	.	.	.	.	84	81
Feb.	7 .	189	382	.	.	.	.	.	.	.	.	189	382
"	14 .	395	712	.	.	.	.	.	.	.	.	395	712
"	21 .	325	4102	.	.	.	.	.	.	.	.	325	4102
"	28 .	120	559	.	.	.	.	.	.	.	.	120	559
March	7 .	271	1666	.	.	.	.	.	.	.	.	271	1666
"	14 .	289	12033	.	.	.	.	.	.	.	.	289	12033
"	21 .	160	360	.	.	.	.	.	.	.	.	160	360
"	28 .	35	35	.	.	.	.	.	.	.	.	35	35
April	4 .	.	.	.	.	.	.	.	.	.	.	.	.
"	11 .	.	.	.	.	.	.	.	.	.	.	.	.
"	18 .	.	.	.	.	.	.	.	.	.	.	.	.
"	25 .	.	.	.	.	.	.	.	.	.	.	.	.
May	2 .	.	.	.	.	.	.	.	.	.	.	.	.
"	9 .	10	34	.	.	.	.	.	.	.	.	10	34
"	16 .	17	8	.	.	.	.	.	.	.	.	17	8
"	23 .	57	95	.	.	.	.	.	.	.	.	57	95
"	30 .	105	160	?	*2363	.	.	.	.	.	.	105	160
June	6 .	114	385	124	109	204	2117	.	.	.	.	442	2611
"	13 .	131	271	209	955	206	1744	?	†142	.	.	546	2970
"	20 .	108	259	312	787	214	1214	40	82	?	*1050	674	2342
"	27 .	145	303	296	677	215	2112	48	94	140	190	844	3376

\* From 1st January.

† Up to date.



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1886.												
May 1	.	.	.	.	.	.	.	.	.	.	.	.
" 8	.	.	.	.	.	.	.	.	.	.	.	.
" 15	.	.	.	.	.	.	.	.	.	.	.	.
" 22	.	.	.	.	.	.	.	.	.	.	.	.
" 29	24	27	?	*407	.	.	.	.	.	.	24	27
June 5	30	9	272	813	130	581	.	.	.	.	432	1403
" 12	76	41	216	180	188	756	.	.	.	.	480	977
" 19	55	15	183	154	186	451	.	.	.	.	424	620
" 26	96	128	350	928	174	1133	?	†15	.	.	620	2189
July 3	108	190	380	367	182	1502	21	29	?	*125	691	2088
" 10	116	403	276	815	198	533	51	86	121	260	762	2097
" 17	97	134	292	720	216	912	33	56	94	180	732	2002
" 24	93	186	200	144	236	1049	46	74	57	114	632	1567
" 31	87	232	202	638	201	596	56	105	97	59	643	1630
Aug. 7	82	145	274	1294	198	874	51	59	72	141	677	2513
" 14	69	95	300	664	196	1251	45	65	47	82	657	2157
" 21	54	111	290	1093	194	1150	48	158	96	232	682	2744
" 28	37	44½	282	1268	193	1672	25	28	105	148½	642	3161
Sept. 4	24	44	200	1915	188	1082	8	2½	19	20	439	3063½
" 11	11	½	100	94	190	11	.	.	5	½	306	106
" 18	8	8½	130	67	102	552	5	10	16	22	261	659½
" 25	14	41	180	83	113	256	4	.	22	33	333	413
Oct. 2	.	.	180	525	162	120	.	.	45	48	387	693
" 9	21	59	185	318	168	45	.	.	284	1138	658	1560
" 16	22	16	110	146	168	63	.	.	215	163	515	388
" 23	22	39	311	647	168	111	.	.	190	340	691	1137
" 30	17	92	223	934	171	43	.	.	170	270	581	1339
Nov. 6	.	.	108	360	164	.	.	.	130	180	402	540
" 13	14	14	124	523	130	46	.	.	110	130	378	713
" 20	4	4	234	565	130	35	.	.	85	115	453	719
" 27	18	10	400	1666	130	95	.	.	110	145	658	1916
Dec. 4	13	18	220	2305	55	143	.	.	95	148	383	2614
" 11	14	15	20	135	.	.	.	.	.	.	34	150
" 18	.	.	315	5350	.	.	.	.	85	340	400	5690
" 25	3	4	.	.	.	.	.	.	.	.	3	4
1887.												
Jan. 1	18	.	.	.	.	.	.	.	.	.	18	.
" 8	12	.	.	.	.	.	.	.	.	.	12	.
" 15	29	9	.	.	.	.	.	.	.	.	29	9
" 22	29	19	.	.	.	.	.	.	.	.	29	19
" 29	24	20	.	.	.	.	.	.	.	.	24	20
Feb. 5	21	18	.	.	.	.	.	.	.	.	21	18
" 12	50	132	.	.	.	.	.	.	.	.	50	132
" 19	70	188	.	.	.	.	.	.	.	.	70	188
" 26	113	416	.	.	.	.	.	.	.	.	113	416

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1887.													
March	5	110	5084	.	.	.	.	.	.	.	.	110	5084
"	12	144	3707	.	.	.	.	.	.	.	.	144	3707
"	19	53	283	.	.	.	.	.	.	.	.	53	283
"	26	.	.	.	.	.	.	.	.	.	.	.	.
April	2	.	.	.	.	.	.	.	.	.	.	.	.
"	9	.	.	.	.	.	.	.	.	.	.	.	.
"	16	.	.	.	.	.	.	.	.	.	.	.	.
"	23	.	.	.	.	.	.	.	.	.	.	.	.
"	30	.	.	.	.	.	.	.	.	.	.	.	.
May	7	.	.	.	.	118	525	.	.	.	.	118	525
"	14	.	.	.	.	126	90	.	.	.	.	126	90
"	21	.	.	.	.	136	34	.	.	.	.	136	34
"	28	7	15	?	*6210	152	383	.	.	.	.	159	398
June	4	42	36	92	33178	731	.	.	.	.	.	312	800
"	11	58	113	146	47222	940	.	.	.	.	.	426	1100
"	18	59	77	212	429260	720	.	.	.	.	.	531	1226
"	25	81	90	300	496262	575	?	†18	.	.	.	643	1161
July	2	77	115	320	258258	611	24	18	?	*250	.	679	1002
"	9	82	240	420	1030240	268	19	58½	112	55	.	873	1651½
"	16	99	176	350	1272245	777	37	183½	83	339½	.	814	2748
"	23	65	125	289	1543255	1769	43	165	113	576½	.	765	4178½
"	30	37	62½	205	625½	255	408	45	108½	192	949	734	2153½
Aug.	6	58	228½	166	518255	1289	44	177	93	420	.	616	2632½
"	13	50	95	220	911½	255	901	40	148½	3001	140	865	3196
"	20	47	120½	182	821½	255	392	61	381	116	401	661	2095½
"	27	15	20½	180	1080243	94	57	148½	3401	004	.	835	2347
Sept.	3	11	4½	125	355253	413	28	82½	92	305½	.	509	1160½
"	10	11	16	176	1236243	159½	38	45	55	145½	.	523	1602
"	17	8	2	204	2883233	716	10	52	76	423½	.	531	4076½
"	24	4	12	207	5149233	1349	13	70	8	86½	.	465	6667
Oct.	1	.	.	201	550225	215	.	.	112	720	.	538	1485
"	8	.	.	2001	065204	20	.	.	105	270	.	509	1355
"	15	.	.	76	65196	333	.	.	150	320	.	422	718
"	22	.	.	224	2054176	184	.	.	210	520	.	610	2758
"	29	7	153	238	122176	244	.	.	165	540	.	586	1059
Nov.	5	23	59	384	3123178	168	.	.	80	240	.	665	3590
"	12	14	36	666	7057168	30	.	.	200	690	.	1048	7813
"	19	16	6	224	42158	.	.	.	65	180	.	463	228
"	26	4	2	380	447104	.	.	.	55	130	.	543	579
Dec.	3	.	.	5001	87560	22	.	.	85	550	.	645	2447
"	10	16	31	4101	22930	.	.	.	35	90	.	491	1350
"	17	16	32	280	17	.	.	.	.	.	.	296	49
"	24	7	4	520	992	.	.	.	12	30	.	539	1026
"	31	7	3	.	.	.	.	.	.	.	.	7	3

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbelltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1888.													
Jan.	7	7	13	.	.	.	.	.	.	.	.	7	13
"	14	47	317	.	.	.	.	.	.	.	.	47	317
"	21	37	65	.	.	.	.	.	.	.	.	37	65
"	31	30	55	.	.	.	.	.	.	.	.	30	55
Feb.	4	22	52	.	.	.	.	.	.	.	.	22	52
"	11	26	133	.	.	.	.	.	.	.	.	26	133
"	18	38	537	.	.	.	.	.	.	.	.	38	537
"	25	51	1405	.	.	.	.	.	.	.	.	51	1405
March	3	147	6786	.	.	.	.	.	.	.	.	147	6786
"	10	23	152	.	.	.	.	.	.	.	.	23	152
"	17	.	.	.	.	.	.	.	.	.	.	.	.
"	24	.	.	.	.	.	.	.	.	.	.	.	.
"	31	.	.	.	.	.	.	.	.	.	.	.	.
April	7	.	.	.	.	.	.	.	.	.	.	.	.
"	14	.	.	.	.	.	.	.	.	.	.	.	.
"	21	.	.	.	.	.	.	.	.	.	.	.	.
"	28	.	.	.	.	.	.	.	.	.	.	.	.
May	5	.	.	.	.	.	.	.	.	.	.	.	.
"	12	.	.	.	.	.	.	.	.	.	.	.	.
"	19	.	.	.	.	.	.	.	.	.	.	.	.
"	26	37	66	.	.	.	.	.	.	.	.	37	66
June	2	60	24									60	24
"	9	54	53	100	*10890	20	152	18	.	.	.	306	91
"	16	69	38	133	46	198	248	?	+86	.	.	400	332
"	23	79	73	139	116	235	184	53	123	?	*697	506	496
"	30	83	349	269	522	268	661	78	479	105	377	803	2388
July	7	68	355	380	1088	2511	655	82	276	108	540	889	3914
"	14	57	585	376	1008	2491	518	81	370	136	1010	899	4491
"	21	72	272	326	1634	2362	236	33	67	113	169	780	4378
"	28	65	116	340	960	2271	738	83	498	96	1171	811	4483
Aug.	4	48	192	162	1959	2261	961	59	366	180	1233	675	5711
"	11	40	80	165	821	2172	608	56	326	138	1176	616	5013
"	18	29	6	190	1502	2112	237	57	240	176	843	661	4885
"	25	27	3	296	388	196	1073	51	139	55	162	625	1795
Sept.	1	27	35	350	1678	178	760	12	55	114	600	681	3130
"	8	5	1	266	558	178	592	15	20	69	194	533	1366
"	15	.	.	272	1425	178	1711	18	21	198	795	666	2953
"	22	.	.	204	100	170	64	15	.	14	3	403	168
"	29	3	7	93	195	93	551	12	2	3	3	204	758
Oct.	6	12	43	264	908	92	360	.	.	23	26	391	1338
"	13	14	77	210	2204	167	349	.	.	85	312	476	2942
"	20	2	16	250	1372	180	267	.	.	69	102	501	1757
"	27	15	13	223	218	162	115	.	.	55	50	455	396

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans.
1888.												
Nov. 3 .	.	.	226	1465	162	.	.	.	43	65	431	1530
" 10 .	.	.	.	.	120	.	.	.	.	.	120	.
" 17 .	.	.	216	648	112	260	.	.	25	43	353	951
" 24 .	.	.	90	146	112	.	.	.	6	13	208	159
Dec. 1 .	.	.	268	2753	94	89	.	.	45	250	407	3092
" 8 .	.	.	270	1797	94	.	.	.	25	50	389	1847
" 15 .	40	665	390	2388	86	.	.	.	15	33	531	3086
" 22 .	54	172	380	2307	.	.	.	.	.	.	434	2479
" 29 .	52	76	180	250	.	.	.	.	.	.	232	326
1889.												
Jan. 5 .	25	55	.	.	.	.	.	.	.	.	25	55
" 12 .	48	233	.	.	.	.	.	.	.	.	48	233
" 19 .	39	61	.	.	.	.	.	.	.	.	39	61
" 26 .	66	526	.	.	.	.	.	.	.	.	66	526
Feb. 2 .	.	.	.	.	.	.	.	.	.	.	.	.
" 9 .	92	280	.	.	.	.	.	.	.	.	92	280
" 16 .	4	9	.	.	.	.	.	.	.	.	4	9
" 23 .	121	2266	.	.	.	.	.	.	.	.	121	2266
March 2 .	155	6426	.	.	.	.	.	.	.	.	155	6426
" 9 .	48	745	.	.	.	.	.	.	.	.	48	745
" 16 .	6	14	.	.	.	.	.	.	.	.	6	14
" 23 .	.	.	.	.	.	.	.	.	.	.	.	.
" 30 .	.	.	.	.	.	.	.	.	.	.	.	.
April 6 .	.	.	.	.	.	.	.	.	.	.	.	.
" 13 .	.	.	.	.	.	.	.	.	.	.	.	.
" 20 .	.	.	.	.	.	.	.	.	.	.	.	.
" 27 .	.	.	.	.	.	.	.	.	.	.	.	.
May 4 .	.	.	.	.	.	.	.	.	.	.	.	.
" 11 .	.	.	.	.	.	.	.	.	.	.	.	.
" 18 .	11	32	.	.	.	.	.	.	.	.	11	32
" 25 .	46	61	.	.	.	.	.	.	.	.	46	61
June 1 .	44	46	?	*7534	.	.	?	64	.	.	44	110
" 8 .	49	50½	124	205	220	486½	61	159½	.	.	454	901½
" 15 .	77	157½	183	590	250	356½	71	89½	.	.	581	1193½
" 22 .	92	145½	110	266	142	538	65	159½	?	*42	409	1109
" 29 .	77	124	110	508	258	449	87	247½	125	452	657	1780½
July 6 .	78	289	180	1285	233	55	72	161½	126	260	689	2050½
" 13 .	55	89½	132	790½	223	1862½	59	58½	120	156	589	2957
" 20 .	63	183½	148	705	220	2504½	75	457½	125	552	631	4402½
" 27 .	48	61½	120	340	219	1942	79	181½	64	425½	530	2950½
Aug. 3 .	52	98½	59	564	208	1397½	56	157	115	868½	490	3085½
" 10 .	43	30	62	331½	208	944	50	122½	106	673	469	2101½
" 17 .	6	13½	61	369½	187	676½	46	149	167	914½	467	2122½
" 24 .	8	3	42	422	206	594	32	32½	113	305	401	1356½
" 31 .	3	1½	44	933½	203	1655	14	15	118	707½	382	3312½

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1889.												
Sept. 7 .	.	.	30	88	187	994½	8	2½	30	56	255	1141
" 14 .	.	.	5	30	203	207½	.	.	56	56½	264	294
" 21 .	.	.	8	212½	92	816½	.	.	7	14½	107	1043½
" 28 .	.	.	85	2061¼	188	1825	1	10½	294	1100	568	4997
Oct. 5 .	.	.	90	1277	159	3237	.	.	248	514	497	5028
" 12 .	.	.	93	1772	159	1060	.	.	17	129½	269	2961½
" 19 .	.	.	180	286	160	2738	.	.	217	670	557	3694
" 26 .	.	.	125	2205	198	1671	.	.	32	238	355	4114
Nov. 2 .	.	.	157	32	198	1419	.	.	60	180	415	1631
" 9 .	.	.	146	1760	198	485	.	.	40	20¼	384	2265¼
" 16 .	.	.	155	1370	206	1371	.	.	45	110	406	2851
" 23 .	8	140	206	4895	206	493	.	.	40	364	460	5892
" 30 .	34	457	191	137	140	87	.	.	35	25	400	706
Dec. 7 .	46	442	202	44	.	.	.	.	20	15	268	501
" 14 .	62	586	283	930	.	.	.	.	.	.	345	1516
" 21 .	58	18	132	939	.	.	.	.	.	.	190	957
" 28 .	30	24	88	23	.	.	.	.	.	.	118	47
1890.												
Jan. 4 .	16	17	.	.	.	.	.	.	.	.	16	17
" 11 .	41	258	.	.	.	.	.	.	.	.	41	258
" 18 .	5	.	.	.	.	.	.	.	.	.	5	.
" 25 .	12	3	.	.	.	.	.	.	.	.	12	3
Feb. 1 .	55	18	.	.	.	.	.	.	.	.	55	18
" 8 .	88	419	.	.	.	.	.	.	.	.	88	419
" 15 .	93	1931	.	.	.	.	.	.	.	.	93	1931
" 22 .	107	559	.	.	.	.	.	.	.	.	107	559
March 1 .	163	4011	.	.	.	.	.	.	.	.	163	4011
" 8 .	174	978	.	.	.	.	.	.	.	.	174	978
" 15 .	.	.	.	.	.	.	.	.	.	.	.	.
" 22 .	.	.	.	.	.	.	.	.	.	.	.	.
" 29 .	.	.	.	.	.	.	.	.	.	.	.	.
April 5 .	.	.	.	.	.	.	.	.	.	.	.	.
" 12 .	.	.	.	.	.	.	.	.	.	.	.	.
" 19 .	.	.	.	.	.	.	.	.	.	.	.	.
" 26 .	.	.	.	.	.	.	.	.	.	.	.	.
May 3 .	16	10	.	.	.	.	.	.	.	.	16	10
" 10 .	22	8½	.	.	.	.	.	.	.	.	22	8½
" 17 .	28	9½	.	.	.	.	.	.	.	.	28	9½
" 24 .	24	4½	.	.	.	.	?	194+	.	.	24	4½
" 31 .	34	17½	?	*12499	.	.	23	24½	.	.	57	42
June 7 .	34	9	121	23	257	160	37	8½	.	.	449	200½
" 14 .	60	32½	165	49	297	205	40	5½	?	*276½	562	292½
" 21 .	38	68½	275	401	276	258	56	38½	22	24	667	790
" 28 .	51	61½	350	684	276	1313	34	30½	20	32	731	2121

\* From 1st January.

† Up to date.



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

[illegible]

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Cranes	Boats	Cranes	Boats	Cranes	Boats	Cranes	Boats	Cranes	Boats	Cranes
1891.													
May	2	.	.	.	.	.	.	.	.	.	.	.	.
"	9	.	15	.	.	.	.	.	.	.	.	?	15
"	16	.	24	.	24	.	.	.	.	.	.	24	24
"	23	.	45	.	37½	.	.	.	35	.	.	45	37½
"	30	.	71	.	164½	.	12845	.	33	.	22	104	186½
June	6	.	50	.	94	.	44	.	71	.	259	779	42
"	13	.	85	.	120½	.	150	.	1143	.	259	657	67
"	20	.	84	.	205½	.	181	.	1585	.	260	365	77
"	27	.	82	.	193½	.	255	.	1320	.	252	358	92
July	4	.	81	.	265	.	216	.	1571	.	252	1821	101
"	11	.	71	.	687½	.	250	.	3069	.	252	1562	93
"	18	.	62	.	306½	.	214	.	1784	.	217	2152	81
"	25	.	52	.	113½	.	180	.	1330	.	213	1965	85
Aug.	1	.	42	.	74½	.	170	.	2222	.	213	2783	77
"	8	.	16	.	22½	.	58	.	940	.	212	1069½	85
"	15	.	21	.	33½	.	67	.	892½	.	214	748	51
"	22	.	15	.	8½	.	68	.	292	.	215	996	28
"	29	.	12	.	1½	.	40	.	284	.	212	970½	8
Sept.	5	.	16	.	14½	.	30	.	120½	.	212	426½	6
"	12	.	.	.	4	.	6½	.	212	.	1082	4	22
"	19	.	2	.	3	.	.	.	212	.	988½	2	14½
"	26	.	.	.	16	.	19	.	212	.	1142	1	6
Oct.	3	.	.	.	20	.	87	.	212	.	792	.	35
"	10	.	.	.	14	.	11½	.	250	.	883	.	31
"	17	.	.	.	21	.	252	.	250	.	1016	.	30
"	24	.	.	.	70	.	390	.	284	.	4000	.	35
"	31	.	24	.	299	.	136	.	504	.	284	2697	40
Nov.	7	.	19	.	171	.	73	.	219	.	300	5001	105
"	14	.	65	.	32	.	22	.	300	.	324	.	35
"	21	.	53	.	460	.	14	.	40	.	284	1593	40
"	28	.	70	.	300	.	8	.	286	.	4120	.	38
Dec.	5	.	77	.	376	.	.	.	266	.	958	.	20
"	12	.	8	.	36	.	.	.	261	.	1471	.	20
"	19	.	120	.	1775	.	.	.	261	.	1015	.	15
"	26	.	110	.	759	.	.	.	261	.	2240	.	.
"	to 31	.	.	.	.	.	.	.	261	.	2253	.	.
1892.													
Jan.	2	.	.	.	.	.	.	.	.	.	.	.	.
"	9	.	.	.	.	.	.	.	.	.	.	.	.
"	16	.	.	.	.	.	.	.	.	.	.	.	.
"	23	.	.	.	.	.	.	.	.	.	.	.	.
"	30	.	.	.	.	.	.	.	.	.	.	.	.
Feb.	6	.	.	.	.	.	.	.	.	.	.	.	.
"	13	.	36	.	187	.	.	.	.	.	.	36	187
"	20	.	46	.	995	.	.	.	.	.	.	46	995
"	27	.	36	.	395	.	.	.	.	.	.	36	395

\* Up to date.

† From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbelltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1892.													
March	5	65	1572	.	.	.	.	.	.	.	.	65	1572
"	12	34	164	.	.	.	.	.	.	.	.	34	164
"	19	.	.	?	*2193	.	.	.	.	.	.	.	.
"	26	.	.	.	.	.	.	.	.	.	.	.	.
April	2	.	.	.	.	.	.	.	.	.	.	.	.
"	9	.	.	.	.	.	.	.	.	.	.	.	.
"	16	.	.	.	.	.	.	.	.	.	.	.	.
"	23	.	.	.	.	.	.	.	.	.	.	.	.
"	30	16	21½	.	.	.	.	.	.	.	.	16	21½
May	7	.	.	.	.	.	.	.	.	.	.	.	.
"	14	28	9	.	.	.	.	.	.	.	.	28	9
"	21	30	16	.	.	.	.	.	.	.	.	30	16
"	28	56	235	.	.	.	.	13	.	.	.	56	248
June	4	61	163	54	54	.	.	19	29	.	.	134	246
"	11	75	43	74	133	258	1372	60	35½	.	.	467	1583½
"	18	82	208	135	431	262	709	66	114½	?	145†	545	1462½
"	25	84	256	189	1039	266	1118	74	104½	96	160	709	2677½
July	2	85	519	225	1160	264	1310	82	183½	128	220	784	3392½
"	9	63	123	203	1654	266	1502	40	114½	120	252	692	3645½
"	16	84	186	200	2099	242	1096	54	80½	90	127½	670	3589½
"	23	75	100	253	1962	227	4055½	69	157½	72	244	696	6518½
"	30	66	121	171	3441	235	2552½	56	87½	117	199½	645	6401½
Aug.	6	16	9	23	1067	266	4330	47	122½	75	162½	427	5691½
"	13	.	.	17	849½	266	1805	31	17½	44	191½	358	2864
"	20	.	.	20	47½	256	2490½	18	6½	56	239½	350	2784
"	27	.	.	15	41½	247	2503	13	40	80	129	355	2713½
Sept.	3	.	.	12	1	243	1722	.	.	23	79½	278	1802½
"	10	.	.	4	2½	267	2296½	.	.	26	73	297	2371½
"	17	.	.	9	13	257	1650	.	.	23	83½	289	1746½
"	24	.	.	6	21	267	2038	.	.	37	133	300	2192
Oct.	1	.	.	.	.	254*	700	.	.	30	65	284	765
"	8	.	.	40	188	243	1449	.	.	20	40½	303	1677½
"	15	.	.	66	380	266	978	.	.	27	45	359	1403
"	22	.	.	88	739	280	1014	.	.	30	102	398	1855
"	29	.	.	88	287	280	200	.	.	30	35	398	522
Nov.	5	.	.	24	25	266	679	.	.	25	20	315	724
"	12	.	.	64	99	266	1237	.	.	20	10	350	1346
"	19	.	.	60	20	268	211	.	.	15	26	343	257
"	26	.	.	66	40	268	1250	.	.	15	80	349	1370
Dec.	3	.	.	42	.	268	400	.	.	10	.	320	400
"	10	.	.	52	166	268	1000	.	.	10	10	330	1176
"	17	.	.	32	11	268	2740	.	.	.	.	300	2751
"	24	.	.	.	.	260	2000	.	.	.	.	260	2000
"	31	34	65	.	.	240	1000	.	.	.	.	274	1065

\* From 1st January to 15th March.

† From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1893.													
Jan.	7	.	.	.	.	.	.	.	.	.	.	.	.
"	14	6	.	.	.	.	.	.	.	.	.	6	.
"	21	.	.	.	.	.	.	.	.	.	.	.	.
"	28	.	.	.	.	.	.	.	.	.	.	.	.
Feb.	4	5	34	.	.	.	.	.	.	.	.	5	34
"	11	.	.	.	.	.	.	.	.	.	.	.	.
"	18	23	175	.	.	.	.	.	.	.	.	23	175
"	25	104	245	.	.	.	.	.	.	.	.	104	245
March	4	.	.	.	.	.	.	.	.	.	.	.	.
"	11	5	.	.	.	.	.	.	.	.	.	5	.
"	18	.	.	.	.	.	.	.	.	.	.	.	.
"	25	.	.	.	.	.	.	.	.	.	.	.	.
April	1	.	.	?	*3001	.	.	.	.	.	.	.	.
"	8	.	.	.	.	.	.	.	.	.	.	.	.
"	15	.	.	.	.	.	.	.	.	.	.	.	.
"	22	.	.	.	.	.	.	.	.	.	.	.	.
"	29	.	.	.	.	.	.	.	.	.	.	.	.
May	6	18	12	.	.	.	.	.	.	.	.	18	12
"	13	6	5	.	.	.	.	.	.	.	.	6	5
"	20	26	18	.	.	.	.	.	.	.	.	26	18
"	27	60	63	.	.	.	.	?	+136	.	.	60	63
June	3	68	77	56	69	.	.	16	16½	.	.	140	162½
"	10	60	46	182	353	295	1000	45	54	?	*20	582	1453
"	17	57	30	197	357	295	464	65	123½	93	75	707	1049½
"	24	43	39	241	714	295	550	58	33	110	143	747	1479
July	1	35	51	251	1018	267	1237	46	38½	120	130	719	2474½
"	8	66	261	272	1792	268	1345	66	105½	61	270	733	3773½
"	15	32	238	211	1106	261	3577½	64	235½	89	440	657	5596½
"	22	44	99	182	1439	242	2560	60	389½	65	382	593	4869½
"	29	27	71	130	1445	242	3320	62	178	80	788	541	5802
Aug.	5	23	61	20	1021	281	2437½	50	260½	47	253½	455	4033½
"	12	13	22	4	985	238	2866½	32	157½	51	289½	534	4320½
"	19	.	.	9	5	283	2538½	24	45	36	114½	347	2702½
"	26	.	.	5	39½	227	673½	13	55	30	90½	279	858½
Sept.	2	1	1	.	16½	262	1559½	31	166½	36	248½	335	1992½
"	9	.	.	.	.	282	1138½	17	46½	26	73	325	1258
"	16	.	.	.	.	265	686½	4	4½	20	29	289	720
"	23	.	.	.	.	236	511½	.	.	21	27	257	538½
"	30	.	.	.	.	236	364	2	15	24	25½	262	404½
Oct.	7	.	.	2	3	214	100	.	.	22	12	238	115
"	14	.	.	.	.	210	17	.	.	12	.	222	17
"	21	.	.	.	.	210	152	.	.	12	8	222	160
"	28	.	.	.	.	210	436	.	.	8	.	218	436

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1893.													
Nov.	4	.	.	.	.	210	1870	.	.	15	68	225	1938
"	11	.	.	.	.	220	800	.	.	15	15	235	815
"	18	.	.	.	.	210	897	.	.	12	30	222	927
"	25	.	.	2	.	208	345	.	.	12	20	222	365
Dec.	2	.	.	.	.	192	504	.	.	.	.	192	504
"	9	.	.	.	.	192	412	.	.	.	.	192	412
"	16	.	.	.	.	169	1000	.	.	.	.	169	1000
"	23	.	.	2	65	169	1000	.	.	.	.	171	1065
"	30	.	.	20	112	191	2027	.	.	.	.	211	2139
1894.													
Jan.	6	.	.	.	.	.	.	.	.	.	.	.	.
"	13	.	.	.	.	.	.	.	.	.	.	.	.
"	20	.	.	.	.	.	.	.	.	.	.	.	.
"	27	.	.	.	.	.	.	.	.	.	.	.	.
Feb.	3	.	.	.	.	.	.	.	.	.	.	.	.
"	10	.	.	.	.	.	.	.	.	.	.	.	.
"	17	3	3	.	.	.	.	.	.	.	.	3	3
"	24	.	.	.	.	.	.	.	.	.	.	.	.
March	3	.	.	.	.	.	.	.	.	.	.	.	.
"	10	.	.	.	.	.	.	.	.	.	.	.	.
"	17	25	72	.	.	.	.	.	.	.	.	25	72
"	24	15	.	.	.	.	.	.	.	.	.	15	.
"	31	.	.	.	.	.	.	.	.	.	.	.	.
April	7	.	.	.	.	.	.	.	.	.	.	.	.
"	14	.	.	.	.	.	.	.	.	.	.	.	.
"	21	.	.	.	.	.	.	.	.	.	.	.	.
"	28	.	.	.	.	.	.	.	.	.	.	.	.
May	5	.	.	.	.	.	.	.	.	.	.	.	.
"	12	12	22½	.	.	.	.	.	.	.	.	12	22½
"	19	20	1½	.	.	.	.	.	.	.	.	20	1½
"	26	28	39	.	.	.	.	.	.	.	.	28	39
June	2	40	107	?	*5000	?	*555	?	8½	.	.	40	115½
"	9	55	150	110	1516	121	66	23	11	.	.	309	1743
"	16	75	140	117	2006	213	153	24	40½	.	.	429	2339½
"	23	84	307	160	824½	229	1125	26	41½	?	144*	499	2298
"	30	93	411	177	3497½	232	1705	40	103½	105	220	647	5936½
July	7	77	370	138	367½	243	2946	29	37½	83	231	570	3952
"	14	76	246	138	1435	258	3842	39	84½	47	182	558	5789½
"	21	68	173	138	522	258	1428	57	46	55	351	576	2520
"	28	73	186	135	1643	245	2611	65	74	55	325	573	4839
Aug.	4	50	43	150	828	276	4136	49	34	73	164	598	5205
"	11	45	39	165	909½	204	1442½	42	23	36	117½	528	2531½
"	18	3	12	162	866	296	759½	29	10½	28	74½	518	1722½
"	25	22	88	149	1200	296	1893	7	2	22	116	496	3299

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued*.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1894.													
Sept.	1	5	4	190	1100	260	1089	13	10½	12	56	480	2259½
"	8	6	6	100	500	242	806	.	.	14	34	362	1346
"	15	11	15	90	171½	235	607	.	.	3	11	339	804½
"	22	3	17	120	800	225	486	.	.	5	24½	353	1327½
"	29	2	5	100	546	200	1125	.	.	15	10½	317	1686½
Oct.	6	1	2	70	388½	193	527	.	.	20	30	284	947½
"	13	.	.	40	106	120	40	.	.	15	29	175	175
"	20	1	8	38	39½	112	424	.	.	15	10	166	481½
"	27	.	.	16	9	120	50	.	.	12	5	148	64
Nov.	3	.	.	6	4	100	20	.	.	.	.	106	24
"	10	.	.	.	.	80	43	.	.	12	8	92	51
"	17	.	.	.	.	210	510	.	.	.	.	210	510
"	24	.	.	.	.	209	170	.	.	12	.	221	170
Dec.	1	.	.	.	.	215	2357	.	.	.	.	215	2357
"	8	.	.	20	.	238	1991	.	.	5	.	263	1991
"	15	.	.	20	.	196	2229	.	.	.	.	216	2229
"	22	.	.	12	.	158	1658	.	.	.	.	170	1658
"	29	.	.	.	.	130	1573	.	.	.	.	130	1573
1895.													
Jan.	5	.	.	.	.	.	.	.	.	.	.	.	.
"	12	.	.	.	.	.	.	.	.	.	.	.	.
"	19	.	.	.	.	.	.	.	.	.	.	.	.
"	26	.	.	.	.	.	.	.	.	.	.	.	.
Feb.	2	.	.	.	.	.	.	.	.	.	.	.	.
"	9	.	.	.	.	.	.	.	.	.	.	.	.
"	16	13	240	.	.	.	.	.	.	.	.	13	240
"	23	29	116	.	.	.	.	.	.	.	.	29	116
March	2	9	1	.	.	.	.	.	.	.	.	9	1
"	9	30	169	.	.	.	.	.	.	.	.	30	169
"	16	37	581	.	.	.	.	.	.	.	.	37	581
"	23	42	414	.	.	.	.	.	.	.	.	42	414
"	30	10	.	.	.	.	.	.	.	.	.	10	.
April	6	.	.	.	.	.	.	.	.	.	.	.	.
"	13	.	.	.	.	.	.	.	.	.	.	.	.
"	20	.	.	.	.	.	.	.	.	.	.	.	.
"	27	.	.	.	.	.	.	.	.	.	.	.	.
May	4	.	.	.	.	.	.	.	.	.	.	.	.
"	11	25	68	.	.	.	.	.	.	.	.	25	68
"	18	33	38	.	.	.	.	.	.	.	.	33	38
"	25	44	65	.	.	.	.	.	.	.	.	44	65
June	1	39	9	?	*7115½	?	*1090	.	.	?	+100	39	9
"	8	53	21	126	239½	154	263	39	31½	60	100	432	654½
"	15	73	127	152	238½	206	505	70	100½	60	106	561	1177½
"	22	81	231	190	284	214	448	71	175½	60	158	616	1296½
"	29	92	339	216	734	233	901	67	188½	94	343	702	2506½

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued.*

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Cranes	Boats	Cranes	Boats	Cranes	Boats	Cranes	Boats	Cranes	Boats	Cranes
1895.													
July	6	85	153	239	1427½	236	1458	76	185½	102	207	738	3431
"	13	63	108	267	1182	249	941	58	106½	93	213	730	2550
"	20	52	115	247	1349½	250	843	57	52	93	200	699	2559½
"	27	70	156	200	555½	150	1029	37	48½	86	160	543	1949
Aug.	3	74	220	210	891	266	2108	61	104	80	141	691	3464
"	10	48	120	186	711	270	1249½	53	85	76	140	633	2305½
"	17	30	19	149	365½	270	1087	33	21½	74	119	556	1612
"	24	.	.	16	35	276	359½	7	7	42	80	341	481½
"	31	.	.	23	74	281	704	12	5½	35	36	351	819½
Sept.	7	.	.	6	10	283	955	8	12½	30	40	327	1017½
"	14	.	.	5	16	299	516	1	4	30	37	335	573
"	21	.	.	2	3	192	134	.	.	17	5	211	142
"	28	.	.	5	11	112	69	.	.	17	7	134	87
Oct.	5	.	.	3	5	45	27	.	.	12	9	60	41
"	12	.	.	7	48	42	36	.	.	.	.	49	84
"	19	.	.	8	20	20	49	.	.	.	.	44	128
"	26	.	.	8	22	14	24½	.	.	.	.	30	56½
Nov.	2	.	.	26	30	20	18½	.	.	.	.	51	48½
"	9	.	.	11	52	157	98	.	.	.	.	173	154
"	16	.	.	6	14	151	177	.	.	.	.	159	193
"	23	.	.	.	.	154	1071	.	.	.	.	154	1071
"	30	.	.	20	52	154	454	.	.	.	.	174	506
Dec.	7	.	.	.	.	150	227	.	.	.	.	150	227
"	14	.	.	20	104	148	765	.	.	.	.	168	869
"	21	.	.	40	32	138	213	.	.	.	.	178	245
"	28	.	.	4	44	18	33	.	.	.	.	22	77
1896.													
Jan.	4	.	.	.	.	.	.	.	.	.	.	.	.
"	11	.	.	.	.	.	.	.	.	.	.	.	.
"	18	.	.	.	.	.	.	.	.	.	.	.	.
"	25	.	.	.	.	.	.	.	.	.	.	.	.
Feb.	1	.	.	.	.	.	.	.	.	.	.	.	.
"	8	.	.	.	.	.	.	.	.	.	.	.	.
"	15	4	185	.	.	.	.	.	.	.	.	4	185
"	22	5	194	.	.	.	.	.	.	.	.	5	194
"	29	.	.	.	.	.	.	.	.	.	.	.	.
March	7	4	.	.	.	.	.	.	.	.	.	4	.
"	14	19	150	.	.	.	.	.	.	.	.	19	150
"	21	.	.	.	.	.	.	.	.	.	.	.	.
"	28	.	.	.	.	.	.	.	.	.	.	.	.
April	4	.	.	.	.	.	.	.	.	.	.	.	.
"	11	.	.	.	.	.	.	.	.	.	.	.	.
"	18	.	.	.	.	.	.	.	.	.	.	.	.
"	25	.	.	.	.	.	.	.	.	.	.	.	.



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbelltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1896.													
May	2	.	.	.	.	.	.	.	.	.	.	.	.
"	9	9	6	.	.	.	.	.	.	.	.	9	6
"	16	7	3	.	.	.	.	.	.	.	.	7	3
"	23	36	32	.	.	.	.	.	.	.	.	36	32
"	30	40	45	?	*2014	?	*2012	.	.	.	.	40	45
June	6	40	92	126	277	121	219	22	26½	.	.	309	614½
"	13	66	158	136	294	189	236	35	27½	.	.	426	715½
"	20	71	99	194	590	214	321	38	36	?	322½	517	1046
"	27	79	194	194½	616	214	668	35	56½	75	120	597	2054½
July	4	68	300	157½	193	221½	090	40	156½	49	234	535	2903½
"	11	67	110	197	739	217	905	41	126	88	354	610	2234
"	18	46	51	240	552	222	770	37	57	61	122	606	1552
"	25	23	14	212	471	232	753	30	40	42	119	539	1397
Aug.	1	24	7	203	425	284	426	16	18	36	108	563	984
"	8	14	51	140	710	276½	505	19	83	39	317	488	2666
"	15	17	28	154	415	261	491	14	31	31	88	477	1053
"	22	4	15	149	305	210½	166	8	3	31	97	402	1586
"	29	5	10	193	674	210	429	6	1	18	46	432	1160
Sept.	5	5	12	163	218	278½	090	.	.	23	127	469	1447
"	12	1	2	143	276	238	684	.	.	16	60	398	1022
"	19	.	.	73	125	98	294	.	.	4	22	175	441
"	26	9	22	56	490	161	246	.	.	16	27	242	785
Oct.	3	16	105	731	867	193	899	.	.	20	115	302	2986
"	10	14	26	61	200	178	654	.	.	10	40	263	920
"	17	14	16	49	61	169	381	.	.	15	38	247	496
"	24	10	10	.	.	102	55	.	.	12	.	124	65
"	31	6	4	48	329	157	416	.	.	24	60	235	809
Nov.	7	.	.	45	53	164½	515	.	.	18	30	227	1598
"	14	.	.	40	72	158	117	.	.	.	.	198	189
"	21	.	.	.	.	168	427	.	.	.	.	168	427
"	28	.	.	14	335	134	383	.	.	.	.	148	718
Dec.	5	.	.	10	26	134	128	.	.	.	.	144	154
"	12	.	.	2	1	134	100	.	.	.	.	136	101
"	19	.	.	10	147	122	96	.	.	.	.	132	243
"	26	.	.	26	198	37	.	.	.	.	.	63	198
1897.													
Jan.	2	.	.	.	.	.	.	.	.	.	.	.	.
"	9	.	.	.	.	.	.	.	.	.	.	.	.
"	16	.	.	.	.	.	.	.	.	.	.	.	.
"	23	.	.	.	.	.	.	.	.	.	.	.	.
"	30	.	.	.	.	.	.	.	.	.	.	.	.
Feb.	6	.	.	.	.	.	.	.	.	.	.	.	.
"	13	.	.	.	.	.	.	.	.	.	.	.	.
"	20	9	28	.	.	.	.	.	.	.	.	9	28
"	27	12	18	.	.	.	.	.	.	.	.	12	18

\* From 1st January.

† Up to date.



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1897.													
March	6	14	17	.	.	.	.	.	.	.	.	14	17
"	13	19	260	.	.	.	.	.	.	.	.	19	260
"	20	18	146	.	.	.	.	.	.	.	.	18	146
"	27	.	.	.	.	.	.	.	.	.	.	.	.
April	3	.	.	.	.	.	.	.	.	.	.	.	.
"	10	.	.	.	.	.	.	.	.	.	.	.	.
"	17	.	.	.	.	.	.	.	.	.	.	.	.
"	24	.	.	.	.	.	.	.	.	.	.	.	.
May	1	.	.	.	.	.	.	.	.	.	.	.	.
"	8	.	.	.	.	.	.	.	.	.	.	.	.
"	15	.	.	.	.	.	.	.	.	.	.	.	.
"	22	.	.	.	.	.	.	.	.	.	.	.	.
"	29	.	.	?	393*	?	849*	.	.	.	.	.	.
June	5	17	7	32	124	139	248	?	+22	.	.	188	379
"	12	20	9	72	22	160	801	13	41	.	.	265	836 $\frac{1}{2}$
"	19	22	7	102	86	179	154	30	41	?	+109	333	247 $\frac{1}{2}$
"	26	15	10	178	556	189	553	24	3	50	68	456	1190
July	3	37	124	205	2076	203	719	30	11 $\frac{3}{4}$	39	113	514	3043 $\frac{3}{4}$
"	10	50	197	220	1598	199	779	33	62	43	103	545	2739
"	17	69	226	220	1774	204	1307	35	70	64	272	592	3649
"	24	58	224	221	2607	212	849	49	92	64	232	604	4004
"	31	62	108	187	1637	226	222	28	93 $\frac{1}{2}$	54	199	557	4259 $\frac{1}{2}$
Aug.	7	43	68	206	1044	233	2342	43	144	52	222	577	3820
"	14	13	5	127	862	298	3204	32	50	42	184	512	4305
"	21	13	20	97	303	307	3035	25	26	42	240	484	3624
"	28	10	17	34	1412	309	2216	21	21	32	103	406	3769
Sept.	4	12	35	137	1139	309	4099	10	13	35	162	503	5448
"	11	12	69	136	1604	309	5831	2	4	33	391	492	7899
"	18	12	64	90	268	309	4046	5	23	23	175	439	4576
"	25	14	41	98	973	298	3622	6	48	45	320	461	5004
Oct.	2	.	.	97	1017	288	2302	.	.	40	60	425	3379
"	9	13	26	86	1745	245	2487	.	.	33	83	377	4341
"	16	13	8	50	664	184	320	.	.	20	51	267	1043
"	23	14	11	78	1135	184	1388	.	.	25	59	301	2593
"	30	11	3	18	162	221	2121	.	.	26	58	276	2344
Nov.	6	.	.	10	164	241	1115	.	.	16	37	267	1316
"	13	.	.	8	79	243	886	.	.	6	5	257	970
"	20	.	.	64	366	270	813	.	.	13	110	347	1289
"	27	.	.	54	328	270	2949	.	.	15	170	339	3447
Dec.	4	.	.	16	2	270	2045	.	.	6	12	292	2059
"	11	.	.	.	.	6	70	.	.	.	.	6	70
"	18	.	.	8	56	217	1728	.	.	.	.	225	1784
"	25	.	.	16	6	227	1320	.	.	.	.	243	1326
"	31	.	.	.	.	107	400	.	.	.	.	107	400

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1898.												
Spring Fishing	?	30	?	816*	?	*736	.	.	.	.	.	.
June 4 .	42	111	100	578	123	95	.	.	.	.	265	784
" 11 .	41	126	169	968	181	550	.	*44	?	†34	391	1644
" 18 .	48	86	1861	044	184	854	24	7	34	133	476	2124
" 25 .	58	240	1861	799	192	971	24	5	35	88½	495	3103½
July 2 .	51	302	1722	032	196	1782	24	11	36	112½	479	4239½
" 9 .	44	181	1722	163	296	2047	12	24	25	85	449	4500
" 16 .	55	82	173	738	204	1976	14	72	47	288	493	3156
" 23 .	53	24	1991	471	240	3960	14	4	48	113	554	5572
" 30 .	50	37	162	565	235	3653	22	44	42	172	511	4471
Aug. 6 .	20	9	125	271	298	1880	8	9	42	146	493	2315
" 13 .	?	47	110	5	307	2374	19	32	37	107	473	2565
" 20 .	?	31	90	639	400	2001	13	21	43	103	546	2795
" 27 .	?	3	86	865	350	2640	7	13	40	122	483	3643
Sept. 3 .	?	1	98	490	310	754	7	1	26	32	441	1278
" 10 .	?	6	306	959	156	1296	3	4	31	108	496	2373
" 17 .	.	.	309	229	188	1697	.	.	25	50	522	1976
" 24 .	.	.	116	927	210	1414	.	.	16	38	342	2379
Oct. 1 .	.	.	80	166	233	539	1	4	24	75	338	784
" 8 .	.	.	40	162	212	1487	.	.	17	28	269	1677
" 15 .	.	.	57	108	235	1212	.	.	15	31	307	1351
" 22 .	.	.	35	89	254	301	.	.	15	34	304	424
" 29 .	.	.	30	28	240	481	.	.	12	6	282	515
Nov. 5 .	.	.	10	4	233	659	.	.	23	24	266	687
" 12 .	.	.	50	556	220	883	.	.	20	150	290	1589
" 19 .	.	.	150	458	120	510	.	.	21	48	291	1016
" 26 .	.	.	1541	098	179	1725	.	.	.	.	333	2823
Dec. 3 .	.	.	1201	262	91	1383	.	.	.	.	211	2645
" 10 .	.	.	80	576	91	843	.	.	.	.	171	1419
" 17 .	.	.	901	342	129	.	.	.	.	.	219	1342
" 24 .	.	.	961	131	92	98	.	.	.	.	188	1229
" 31 .	.	.	36	278	.	.	.	.	.	.	36	278
1899.												
" Winter."	?	1247	.	.	.	.	?	200	.	.	?	1447
1st to 6th May.	?	15	.	.	.	.	.	.	.	.	?	15
May 13 .	?	38	.	.	.	.	.	.	.	.	?	38
" 20 .	23	58	.	.	.	.	.	.	.	.	23	58
" 27 .	35	34	.	*4120	.	.	.	.	.	.	35	34
June 3 .	39	66	72	209	.	.	.	.	.	.	111	275
" 10 .	41	77	941	066	165	678	.	.	.	.	300	1821
" 17 .	51	117	1261	212	170	526	16	4	?	273*	363	1859
" 24 .	56	69	150	582	179	423	20	5	39	57	444	1136
July 1 .	56	71	1661	190	188	1386	18	8½	39	62	467	2717½
" 8 .	48	71	1601	254	190	1832	14	11	39	105	451	3273
" 15 .	36	70	1261	988	190	2304	10	14	20	119	382	4495
" 22 .	16	124	1761	493	197	2666	3	7	24	120	416	4298
" 29 .	30	71	1761	314	200	1750	12	6	27	67	445	3208½

\* From 1st January.

† Up to date.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued*.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1899.													
Aug.	5 .	33	68	1782	703	200	2360	21	35½	24	189	456	5355½
"	12 .	24	154	1781	381	200	3320	22	78	27	164	451	5097
"	19 .	56	109	1781	601	260	1795	29	89	34	160	557	3754
"	26 .	12	6½	72	90	260	934	25	39	19	132	388	1201½
Sept.	2 .	32	11	197	1164	110	1164	9	7½	25	175	373	2521½
"	9 .	10	3	198	902	110	579	13	6½	21	145	352	1635½
"	16 .	11	8	255	3767	92	529	7	2½	25	184	390	4490½
"	23 .	13	50	137	855	13	329	13	59	15	33	191	1326
"	30 .	13	59	125	611	190	1462	5	2	20	68	353	2202
Oct.	7 .	16	87	94	112	97	740	3	1	15	77	225	1017
"	14 .	17	24	105	1376	160	132	.	.	13	111	295	1643
"	21 .	18	17	.	.	193	360	.	.	25	287	236	664
"	28 .	16	10	.	.	193	459	.	.	30	553	239	1022
Nov.	4 .	14	82	.	.	230	1079	.	.	25	8	269	1169
"	11 .	15	62	.	.	230	445	.	.	16	26	261	533
"	18 .	15	20	60	218	230	437	.	.	24	242	329	917
"	25 .	4	1	78	1957	230	1346	.	.	20	182	332	3486
Dec.	2 .	.	.	70	542	230	491	.	.	.	.	300	1033
"	9 .	.	.	.	.	220	644	.	.	.	.	220	644
"	16 .	.	.	.	.	200	1809	.	.	.	.	200	1809
"	23 .	.	.	50	13	120	134	.	.	.	.	170	147
"	30 .	.	.	50	178	.	.	.	.	.	.	50	178
"	1-31 .	?	190	.	.	.	.	.	.	.	.	?	190
1900.													
" Winter."													
Feb.	17 .	20	93	.	.	.	.	.	.	.	.	20	93
"	24 .	57	356	.	.	.	.	.	.	.	.	57	356
March	3 .	64	752	.	.	.	.	.	.	.	.	64	752
"	10 .	68	2912	.	.	.	.	.	.	.	.	68	2912
May	26 .	7	18	?	*3994	?	*13	.	.	.	.	7	18
June	2 .	41	88	120	373	160	124	.	.	.	.	321	585
"	9 .	37	96	158	979	170	604	.	.	.	.	365	1679
"	16 .	40	201	130	401	175	417	18	26	?	104*	363	1045
"	23 .	53	144	140	1360	180	967	19	28	23	38	415	2537
"	30 .	55	126	158	1184	190	1635	23	24	24	68	450	3037
July	7 .	41	74	158	1737	190	1239	18	3½	30	85	437	3138½
"	14 .	33	65	140	1371	188	1457	5	6	22	58	388	2957
"	21 .	22	70	130	2057	196	3633	8	19	20	106	376	5885
"	28 .	38	71	128	1797	210	1194	4	3	33	66	413	3131
Aug.	4 .	28	43	130	1892	210	411	5	15	17	71	390	2432
"	11 .	25	186	200	3981	150	357	8	6	26	97	409	4627
"	18 .	20	68	200	1815	180	1635	8	6	22	99	430	3623
"	25 .	8	11	104	1764	220	2480	.	.	22	101	354	4356

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1900.													
Sept.	1 .	6		8	160	1903	180	440		19	107	365	2458
"	8 .	6		2	200	1806	150	1187	4	22	24	130	3147
"	15 .	11		34	190	2502	140	511	3	7	24	123	3177
"	22 .				190	1956	190	673	2	3	23	56	2688
"	29 .				190	2632	140	1127			30	400	4159
Oct.	6 .	11		31	170	2574	160	475			18	63	3143
"	13 .	6		3	120	70	130	232	2	4½			309½
"	20 .	13		9	180	890	150	762			8	18	1679
"	27 .				140	567	170	67					634
Nov.	3 .				104	27	170	916					943
"	10 .				100	64	200	24					88
"	17 .				90	405	190	156					561
"	24 .				90	114	180	525					639
Dec.	1 .	13		11	90		170	50					61
"	8 .				84	342	200	1399					1741
"	15 .						150						
"	22 .						120	33					33
"	29 .												
1901.													
"	" Winter "								?	12½		?	12½
Feb.	9 .	32		100								32	100
"	16 .	70		1641								70	1641
"	23 .	116		2107								116	2107
March	2 .	118		1804								118	1804
"	9 .	49		159								49	159
"	16 .	66		3205								66	3205
"	23 .	31		379								31	379
"	30 .												
May	11 .	9		20								9	20
"	18 .	18		27			?	*100				18	27
"	25 .	19		41			140	38				159	79
June	1 .	25		22	?	*6097	150	184				175	206
"	8 .	35		312	150	982	175	462				360	1756
"	15 .	31		32	170	595	175	195	10	3		396	825
"	22 .	44		36	175	1237	175	311	18	7½	?	281*	1591½
"	29 .	40		117	180	907	185	1968	18	4½	11	57	3053½
July	6 .	54		127	160	1243	200	1987	18	26	22	115	3498
"	13 .	39		69	160	705	200	1279	7	12	16	109	2174
"	20 .	18		53	150	1709	200	1038	10	11	34	141	2952
"	27 .	14		14	130	2604	200	1664	13	78	22	141	4501
Aug.	3 .	30		18	140	867	200	1400	11	16	27	102	2403
"	10 .	20		36	200	1333	190	2087	11	9	23	128	3593
"	17 .	25		63	150	1959	180	1459	14	15	22	121	3617
"	24 .	4		4	210	3162	200	2623	14	25	25	225	6039
"	31 .				80	327	240	921	4	9	10	50	1307

\* From 1st January.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1901.												
Sept. 7 .	8	6	90	1032	240	2306	3	7	18	149	359	3500
" 14 .	10	15	140	563	240	3541	4	10	16	91	410	4220
" 21 .	8	10	100	669	210	729	.	.	16	13	334	1421
" 28 .	8	12	170	977	180	601	3	3	16	27	377	1620
Oct. 5 .	.	.	130	864	170	665	3	2	10	38	313	1569
" 12 .	.	.	150	17	150	369	.	.	4	7	304	393
" 19 .	.	.	100	13	130	141	.	.	.	.	230	154
" 26 .	.	.	90	.	120	50	.	.	.	.	210	50
Nov. 2 .	.	.	.	.	120	140	.	.	.	.	120	140
" 9 .	.	.	.	.	130	34	.	.	.	.	130	34
" 16 .	.	.	50	55	90	345	.	.	.	.	140	400
" 23 .	.	.	50	107	140	275	.	.	.	.	190	382
" 30 .	.	.	98	919	180	89	.	.	.	.	278	1008
Dec. 7 .	.	.	110	1396	150	94	.	.	.	.	260	1490
" 14 .	.	.	115	326	150	15	.	.	.	.	265	341
" 21 .	.	.	90	124	150	1649	.	.	.	.	240	1773
" 28 .	.	.	70	560	120	358	.	.	.	.	190	918
1902.												
Winter	.	.	?	3881	.	.	.	.	.	.	?	3881
Jan. 11 .	10	14	.	.	.	.	.	.	.	.	10	14
" 18 .	46	591	.	.	.	.	.	.	.	.	46	591
" 25 .	92	1064	.	.	.	.	.	.	.	.	92	1064
Feb. 1 .	100	781	.	.	.	.	.	.	.	.	100	781
" 8 .	105	389	.	.	.	.	.	.	.	.	105	389
" 15 .	97	831	.	.	.	.	.	.	.	.	97	831
" 22 .	97	549	.	.	.	.	.	.	.	.	97	549
March 1 .	108	1303	.	.	.	.	.	.	.	.	108	1303
" 8 .	108	1302	.	.	.	.	.	.	.	.	108	1302
" 15 .	90	14	.	.	.	.	.	.	.	.	90	14
" 22 .	.	.	.	.	.	.	.	.	.	.	.	.
" 29 .	.	.	.	.	.	.	.	.	.	.	.	.
May 3 .	.	.	.	.	.	.	.	.	.	.	.	.
" 10 .	8	28	.	.	.	.	.	.	.	.	8	28
" 17 .	9	18	.	.	.	.	.	.	.	.	9	18
" 24 .	16	18	.	.	.	.	.	.	.	.	16	18
" 31 .	30	81	.	.	.	.	.	.	.	.	30	81
June 7 .	36	131	210	991	150	124	.	.	.	.	396	1246
" 14 .	36	130	150	1692	160	154	.	.	.	.	346	1976
" 21 .	10	4	170	1384	170	210	.	.	.	.	350	1598
" 28 .	25	60	180	828	180	363	.	.	18	58	403	1309
July 5 .	35	152	180	2513	190	1212	.	.	19	104	424	3981
" 12 .	30	62	180	1939	190	350	6	31	14	71	420	2453
" 19 .	32	77	170	2576	205	1737	10	7	16	92	433	4489
" 26 .	34	83	140	2387	220	798	15	18	29	149	438	3435

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1902.													
Aug.	2	49	92	190	2565	200	2276	14	42	32	208	485	5183
"	9	27	32	210	2933	190	1163	14	23	42	184	483	4335
"	16	26	42	210	3494	180	2033	12	23	34	157	462	5749
"	23	6	12	220	2023	190	763	15	24	25	67	456	2889
"	30	18	20	220	3277	190	1693	8	17	35	152	471	5159
Sept.	6	.	.	210	1743	200	1382	6	11	14	57	430	3193
"	13	.	.	190	2258	220	1697	.	.	24	120	434	4075
"	20	.	.	60	70	220	720	3	1	8	24	291	815
"	27	.	.	100	.	220	402	.	.	8	23	328	425
Oct.	4	.	.	90	.	210	820	.	.	11	55	311	875
"	11	.	.	20	203	110	1196	120	113	90	500	340	2012
"	18	.	.	.	.	110	204	140	1064	90	870	340	2138
"	25	.	.	40	8	170	858	10	204	90	500	310	1570
Nov.	1	.	.	30	106	120	981	.	.	68	780	218	1867
"	8	.	.	10	25	140	1109	.	.	87	2808	237	3942
"	15	.	.	.	.	120	517	.	.	148	718	268	1235
"	22	.	.	2	5	160	493	.	.	142	3599	304	4097
"	29	.	.	.	.	160	394	.	.	216	5219	376	5613
Dec.	6	.	.	2	1	160	234	.	.	195	3467	357	3702
"	13	.	.	2	3	150	283	.	.	226	2883	378	3169
"	20	.	.	.	.	150	1304	.	.	104	1727	254	3031
"	27	.	.	60	287	140	408	.	.	112	1070	312	1765
"	27-31	.	.	70	824	120	461	.	.	.	.	190	1285
1903.													
" Winter "	.	.	.	?	4430	?	12	.	28	.	.	?	4470
Jan.	3	.	.	.	.	.	.	.	.	55	961	55	961
"	10	20	130	.	.	.	.	.	.	157	1938	177	2068
"	17	38	83	.	.	.	.	.	.	112	2630	150	2713
"	24	39	271	.	.	.	.	.	.	62	412	101	683
"	31	20	46	.	.	.	.	.	.	56	1190	76	1236
Feb.	7	28	45	.	.	.	.	.	.	40	144	68	189
"	14	28	94	.	.	.	.	.	.	.	.	28	94
"	21	40	26	.	.	.	.	.	.	.	.	40	26
"	28	5	12	.	.	.	.	.	.	.	.	5	12
March	7	8	17	.	.	.	.	.	.	.	.	8	17
"	14	30	8	.	.	.	.	.	.	.	.	30	8
"	21	.	.	.	.	.	.	.	.	.	.	.	.
"	28	.	.	.	.	.	.	.	.	.	.	.	.
May	9	2	3	.	.	.	.	.	.	.	.	2	3
"	16	7	6	.	.	.	.	.	.	.	.	7	6
"	23	18	60	.	.	.	.	.	.	.	.	18	60
"	30	25	27	.	.	.	.	.	.	.	.	25	27
June	6	17	30	200	623	150	63	.	.	.	.	367	716
"	13	23	49	170	575	150	266	.	.	.	.	343	890
"	20	37	71	180	946	180	244	.	.	.	.	397	1261
"	27	38	190	150	1036	190	292	.	.	9	21	387	1539

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1903.													
July	4	36	299	150	962	190	785	2	7	14	54	392	2107
"	11	40	288	146	2043	185	2347	6	70	16	59	393	4807
"	18	40	242	150	1573	195	2375	9	32	22	61	416	4283
"	25	38	94	155	2302	186	1946	14	87	28	132	421	4561
Aug.	1	29	39	160	2208	195	1850	14	60	27	107	425	4264
"	8	.	.	170	1815	190	1053	13	25	20	114	393	3007
"	15	2	2	180	2957	190	407	11	12	16	118	399	3496
"	22	1	7	185	2844	185	682	.	.	17	71	388	3604
"	29	3	5	195	2181	180	335	3	1	19	48	400	2570
Sept.	5	31	27	190	608	185	1458	.	.	39	286	445	2379
"	12	12	6	96	86	250	1153	3	2	99	630	460	1877
"	19	1	4	75	.	240	2221	.	.	102	1482	418	3707
"	26	.	.	50	.	240	1679	4	8	160	929	454	2616
Oct.	3	21	20	6	.	240	609	.	.	5	35	272	664
"	10	.	.	20	.	150	123	.	.	.	.	170	123
"	17	.	.	10	.	130	515	.	.	64	648	204	1163
"	24	.	.	6	.	170	30	.	.	321	1649	497	1679
"	31	.	.	4	.	140	.	.	.	52	612	196	612
Nov.	7	.	.	10	.	150	48	.	.	144	965	304	1013
"	14	.	.	12	.	130	.	.	.	126	312	268	312
"	21	.	.	10	.	90	.	.	.	130	767	230	767
"	28	.	.	60	272	150	63	.	.	113	673	323	1008
Dec.	5	.	.	80	902	140	.	.	.	95	880	315	1782
"	12	.	.	84	142	140	22	.	.	134	2607	358	2771
"	19	.	.	80	261	150	4	.	.	160	3456	390	3721
"	26	.	.	86	864	160	616	.	.	108	3311	354	4791
"	26-31	.	.	24	132	160	.	.	.	61	643	245	775
1904.													
Winter	.	.	.	?	5872	?	16	?	18	?	2843	?	8749
Jan.	2	.	.	.	.	.	.	.	.	.	.	.	.
"	9	.	.	.	.	.	.	.	.	.	.	.	.
"	16	.	?	5	.	.	.	.	.	.	.	?	5
"	23	21	24	.	.	.	.	.	.	.	.	21	24
"	30	25	63	.	.	.	.	.	.	.	.	25	63
Feb.	6	24	67	.	.	.	.	.	.	.	.	24	67
"	13	30	43	.	.	.	.	.	.	.	.	30	43
"	20	49	307	.	.	.	.	.	.	.	.	49	307
"	27	33	44	.	.	.	.	.	.	.	.	33	44
March	5	23	23	.	.	.	.	.	.	.	.	23	23
"	12	17	105	.	.	.	.	.	.	.	.	17	105
"	19	23	194	.	.	.	.	.	.	.	.	23	194
"	26	.	.	.	.	.	.	.	.	.	.	.	.
April	2	.	.	.	.	.	.	.	.	.	.	.	.
"	9	.	.	.	.	.	.	.	.	.	.	.	.
"	16	.	.	.	.	.	.	.	.	.	.	.	.
"	23	.	.	.	.	.	.	.	.	.	.	.	.
"	30	.	.	.	.	.	?	53	.	.	.	.	.

\* Up to April 30th.



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—*continued*.

Week ended		Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
		Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1904.													
May	7	.	.	.	.	65	17	.	.	.	.	65	17
"	14	.	.	.	.	70	8	.	.	.	.	70	8
"	21	.	.	.	.	90	63	.	.	.	.	90	63
"	28	.	.	.	.	120	164	.	.	.	.	120	164
June	4	13	8	120	564	160	156	.	.	.	.	293	728
"	11	21	46	123	271	180	247	.	.	.	.	324	564
"	18	27	38	104	143	190	381	.	.	.	.	321	562
"	25	30	17	104	402	200	644	.	.	.	.	334	1063
July	2	30	13	114	170	200	380	.	.	7	38	344	601
"	9	35	38	140	363	200	406	2	2	16	46	393	855
"	16	35	48	140	190	200	789	9	9	17	48	401	1084
"	23	41	41	140	982	200	1075	13	16	18	53	412	2167
"	30	32	111	130	403	180	742	18	31	22	57	382	1344
Aug.	6	28	15	140	619	190	402	14	8	39	249	411	1293
"	13	17	21	170	531	185	604	15	14	20	58	407	1228
"	20	9	27	180	350	175	465	11	5	12	30	387	877
"	27	16	15	190	272	170	413	8	2	9	29	393	731
Sept.	3	14	16	180	246	160	205	8	4	94	850	456	1321
"	10	.	.	170	139	150	4	8	.	99	316	427	459
"	17	4	4	160	379	130	45	3	1	5	1	302	430
"	24	5	7	120	26	80	269	4	3	141	709	350	1014
Oct.	1	.	.	70	79	190	42	6	8	170	698	436	827
"	8	.	.	50	45	150	.	.	.	172	225	372	270
"	15	.	.	50	103	130	.	.	.	.	.	180	103
"	22	.	.	60	46	130	1	.	.	20	6	210	53
"	29	.	.	10	24	90	12	.	.	6	7	106	43
Nov.	5	.	.	10	.	.	.	.	.	4	3	14	3
"	12	.	.	6	.	60	.	.	.	9	12	75	12
"	19	.	.	6	.	110	.	.	.	25	23	141	23
"	26	.	.	2	2	50	.	.	.	8	10	60	12
Dec.	3	.	.	2	2	160	12	.	.	171	484	333	498
"	10	.	.	8	.	130	46	.	.	82	12	220	58
"	17	.	.	10	.	140	.	.	.	24	60	174	60
"	24	.	.	80	377	160	150	.	.	90	267	330	794
"	31	.	.	80	306	160	16	.	.	32	139	272	461
1905.													
Winter	.	?	48	?	*5384	?	†558	?	79	?	206	?	843
May	6	.	.	.	.	60	134	.	.	.	.	60	134
"	13	.	.	.	.	110	360	.	.	.	.	110	360
"	20	.	.	.	.	120	398	.	.	.	.	120	398
"	27	.	58†	.	.	130	78	.	.	.	.	130	78
June	3	26	143	100	258	130	8	.	.	.	.	256	409
"	10	24	51	130	1044	100	114	.	.	.	.	254	1209
"	17	17	12	110	535	140	10	.	.	.	.	267	557
"	24	32	77	116	709	160	192	.	.	?	204§	308	978

\* Up to 31st May.

† To 29th April.  
§ Up to 24th June.

‡ Up to date.



TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1905.												
July 1 .	47	77	118	340	170	188	.	.	10	40	345	645
" 8 .	26	128	170	1246	160	90	7	5	10	36	373	1505
" 15 .	32	113	160	1396	165	188	6	6	16	128	379	1831
" 22 .	31	77	180	2057	140	90	3	4	16	67	370	2295
" 29 .	31	61	220	3038	100	72	8	23	17	62	376	3256
Aug. 5 .	29	66	260	1771	40	35	4	2	23	79	356	1953
" 12 .	32	117	300	1717	50	48	10	9	17	33	409	1894
" 19 .	24	112	250	1223	100	96	6	15	113	32	493	1478
" 26 .	32	94	200	348	120	108	8	22	5	26	365	598
Sept. 2 .	39	242	20	116	80	40	10	269	2	11	151	678
" 9 .	15	87	10	5	90	31	9	418	3	222	127	763
" 16 .	9	11	.	.	80	7	10	337	4	147	103	502
" 23 .	13	20	12	1	60	164	10	36	.	.	95	221
" 30 .	9	4	15	.	70	8	128	742	?	22	222	776
Oct. 7 .	.	.	20	.	80	124	50	34	.	.	150	158
" 14 .	.	.	20	.	100	153	30	121	5	62	155	336
" 21 .	.	.	40	2	120	30	66	1298	20	88	246	1418
" 28 .	.	.	20	30	80	21	90	518	6	88	196	657
Nov. 4 .	.	.	20	.	80	21	90	219	1	3	191	243
" 11 .	.	.	10	.	80	100	20	2	.	.	110	102
" 18 .	.	.	8	40	90	4	.	.	.	.	98	44
" 25 .	.	.	30	64	70	36	.	.	6	45	106	145
Dec. 2 .	.	.	30	34	80	258	.	.	9	25	119	317
" 9 .	.	.	8	17	110	.	.	.	.	.	118	17
" 16 .	.	.	30	67	100	866	.	.	5	30	135	963
" 23 .	.	.	20	16	90	42	.	.	8	15	118	73
" 30 .	.	.	.	.	60	.	.	.	.	.	60	.
1906.												
Winter	.	.	.	.	?	14	?	687	?	57	?	758
Feb. 3 .	34	147	.	.	.	.	.	.	.	.	34	147
" 10 .	14	14	.	.	.	.	.	.	.	.	14	14
" 17 .	22	9	.	.	.	.	.	.	.	.	22	9
" 24 .	10	13	.	.	.	.	.	.	.	.	10	13
March 3 .	12	98	.	.	.	.	.	.	.	.	12	98
" 10 .	.	.	.	.	.	.	.	.	.	.	.	.
" 17 .	9	44	.	.	.	.	.	.	.	.	9	44
" 24 .	24	247	.	.	.	.	.	.	.	.	24	247
" 31 .	.	.	.	.	.	.	.	.	.	.	.	.
April 7 .	.	.	.	.	.	.	.	.	.	.	.	.
" 14 .	.	.	.	.	.	.	.	.	.	.	.	.
" 21 .	.	.	.	.	.	.	.	.	.	.	.	.
" 28 .	.	.	.	.	?	*220	.	.	.	.	.	.
May 5 .	.	.	.	.	40	44	.	.	.	.	40	44
" 12 .	.	.	.	.	70	86	.	.	.	.	70	86
" 19 .	.	.	.	.	100	74	.	.	.	.	100	74
" 26 .	.	.	.	.	120	188	.	.	.	.	120	188

\* Up to 28th April.

TABLE XXII., showing the Weekly Catch of Herrings in the Firth of Clyde Districts from 1854-1906—continued.

Week ended	Ballantrae.		Campbeltown.		Inveraray.		Greenock.		Rothesay.		Total.	
	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans	Boats	Crans
1906.												
June 2 .	7	*75	7	13552	120	130	.	.	7	106§	120	130
" 9 .	23	50	100	472	80	224	.	.	.	.	203	746
" 16 .	39	109	120	1261	120	252	.	.	6	32	285	1654
" 23 .	31	15	130	139	120	42	.	.	6	50	287	1246
" 30 .	40	91	136	520	120	188	.	.	10	51	306	850
July 7 .	34	158	134	700	130	359	6	25	10	101	314	1343
" 14 .	47	251	150	673	130	332	12	75	19	89	358	1420
" 21 .	19	17	160	659	120	33	7	8	28	153	334	870
" 28 .	36	127	180	1454	120	298	11	33	20	73	367	1985
Aug. 4 .	33	156	220	175	110	83	12	79	27	55	402	548
" 11 .	36	108	220	207	90	179	13	109	34	184	393	787
" 18 .	19	109	80	50	60	16	19	254	101	567	279	996
" 25 .	27	21	30	12	40	5	18	414	200	435	315	887
Sept. 1 .	27	237	20	97	20	3	18	448	198	1513	283	2298
" 8 .	6	12	.	.	10	1	12	192	204	948	232	1153
" 15 .	25	197	.	.	20	47	13	206	169	547	227	997
" 22 .	26	34	8	1	50	284	17	519	228	247	329	3085
" 29 .	11	17	20	78	80	367	20	713	236	328	367	3503
Oct. 6 .	.	.	10	5	140	1230	11	258	241	686	402	2179
" 13 .	.	.	.	.	150	252	8	20	262	218	420	3490
" 20 .	.	.	.	.	150	2	.	.	250	.	400	2
" 27 .	.	.	.	.	2	.	3	173	250	.	255	173
Nov. 3 .	21	69	.	.	10	.	4	38	7	16	42	123
" 10 .	29	454	.	.	30	255	9	65	5	22	73	796
" 17 .	42	266	.	.	8	.	56	417	5	25	111	708
" 24 .	40	612	.	.	8	.	58	641	.	.	106	1253
Dec. 1 .	52	163	.	.	4	.	164	853	2	9	222	2025
" 8 .	68	1768	.	.	8	.	139	377	5	15	220	2160
" 15 .	125	1499	4	5	.	.	52	575	6	36	187	2115
" 22 .	124	911	.	.	.	.	39	168	12	62	175	5141
" 29 .	70	2017	.	.	4	50	58	518	18	84	150	2669

\* For April and May.

† From 1st January.

§ Up to 2nd June.

**TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854–1906.**

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1854.			1855.			1857.		
July 1 ...	400	800	Dec. 1 ...	230	430	Sept. 5 ...	600	1000
" 8 ...	450	700	" 8 ...	200	250	" 12 ...	540	600
" 15 ...	460	1000	" 15 ...	180	295	" 19 ...	540	400
" 22 ...	465	1000	" 22 ...	...	...	" 26 ...	500	600
" 29 ...	400	1500	" 29 ...	80	324	Oct. 3 ...	450	700
Aug. 5 ...	500	700				" 10 ...	400	800
" 12 ...	550	800	1856.			" 17 ...	400	1200
" 19 ...	540	1500	June 21 ...	280	590	" 24 ...	400	700
" 26 ...	540	2000	" 28 ...	320	650	" 31 ...	400	400
Sept. 2 ...	540	1200	July 5 ...	400	1466	Nov. 7 ...	...	...
" 9 ...	330	800	" 12 ...	420	2106	" 14 ...	...	...
" 16 ...	...	...	" 19 ...	420	1500	" 21 ...	300	1000
" 23 ...	...	...	" 26 ...	460	2710	" 28 ...	100	200
" 30 ...	...	...	Aug. 2 ...	500	3000	1858.		
Oct. 7 ...	...	...	" 9 ...	500	3500	July 3 ...	300	400
" 14 ...	...	...	" 16 ...	560	3300	" 10 ...	450	600
" 21 ...	...	...	" 23 ...	550	3000	" 17 ...	460	450
" 28 ...	300	2400	" 30 ...	580	1500	" 24 ...	480	1100
Nov. 4 ...	...	...	Sept. 6 ...	570	2200	" 31 ...	480	2050
" 11 ...	150	500	" 13 ...	570	3000	Aug. 7 ...	450	1200
" 18 ...	...	...	" 20 ...	500	1500	" 14 ...	480	1400
" 25 ...	140	1100	" 27 ...	480	1500	" 21 ...	480	1500
Dec. 2 ...	80	600	Oct. 4 ...	440	1000	" 28 ...	480	950
1855.			" 11 ...	440	1300	Sept. 4 ...	520	1000
June 23 ...	340	830	" 18 ...	...	...	" 11 ...	520	1950
" 30 ...	390	1473	" 25 ...	...	...	" 18 ...	500	800
July 7 ...	425	2065	Nov. 1 ...	400	4200	" 25 ...	500	900
" 14 ...	380	1674	" 8 ...	400	2360	Oct. 2 ...	400	800
" 21 ...	380	1275	" 15 ...	...	...	" 9 ...	400	300
" 28 ...	425	707	" 22 ...	250	240	" 16 ...	400	1030
Aug. 4 ...	480	1650	" 29 ...	160	150	" 23 ...	500	720
" 11 ...	500	2000	Dec. 6 ...	100	270	" 30 ...	500	950
" 18 ...	500	3000	" 13 ...	70	160	Nov. 6 ...	500	1100
" 25 ...	520	1800	" 20 ...	80	160	" 13 ...	300	600
Sept. 1 ...	520	2200	" 27 ...	40	70	" 20 ...	300	350
" 8 ...	520	1000	1857.			" 27 ...	300	400
" 15 ...	400	200	June 20 ...	200	84	Dec. 4 ...	250	450
" 22 ...	300	200	" 27 ...	280	800	" 11 ...	200	300
" 29 ...	400	600	July 4 ...	275	1060	" 18 ...	100	550
Oct. 6 ...	300	500	" 11 ...	480	1380	" 25 ...	100	100
" 13 ...	300	600	" 18 ...	480	1410	" 31 ...	100	1000
" 20 ...	300	2500	" 25 ...	480	1950	1859.		
" 27 ...	260	380	Aug. 1 ...	500	3000	June 18 ...	220	196
Nov. 3 ...	280	500	" 8 ...	530	800	" 25 ...	290	190
" 10 ...	320	1544	" 15 ...	580	1000	July 2 ...	300	450
" 17 ...	300	1700	" 22 ...	580	2500	" 9 ...	500	1643
" 24 ...	220	150	" 29 ...	600	1300	" 16 ...	480	1800
						" 23 ...	586	1405
						" 30 ...	600	1207

TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854-1906—*continued*.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1859.			1860.			1862.		
Aug. 6 ...	600	1125	Aug. 4 ...	550	680	June 7 ...	30	....
" 13 ...	600	800	" 11 ...	540	500	" 14 ...	70	9
" 20 ...	600	510	" 18 ...	500	600	" 21 ...	190	103
" 27 ...	600	315	" 25 ...	550	2400	" 28 ...	260	102
Sept. 3 ...	600	400	Sept. 1 ...	550	450	July 5 ...	260	117
" 10 ...	600	780	" 8 ...	550	1300	" 12 ...	400	149
" 17 ...	600	800	" 15 ...	500	320	" 19 ...	500	605
" 24 ...	450	620	" 22 ...	550	950	" 26 ...	530	1021
Oct. 1 ...	400	180	" 29 ...	550	2300	Aug. 2 ...	580	1070
" 8 ...	400	470	Oct. 6 ...	560	800	" 9 ...	600	2020
" 15 ...	400	624	" 13 ...	460	1100	" 16 ...	600	1570
" 22 ...	380	566	" 20 ...	410	1500	" 23 ...	585	2660
" 29 ...	390	84	" 27 ...	390	1720	" 30 ...	715	3435
Nov. 5 ...	300	200	Nov. 3 ...	420	2600	Sept. ...	705	2760
" 12 ...	340	100	" 10 ...	430	4500	" 13 ...	689	2275
" 19 ...	310	369	" 17 ...	400	1930	" 20 ...	670	2880
" 26 ...	400	3900	" 24 ...	380	1320	" 27 ...	675	3810
Dec. 3 ...	400	2900	Dec. 1 ...	380	110	Oct. 4 ...	687	3520
" 10 ...	150	100	" 8 ...	208	1950	" 11 ...	690	3725
" 17 ...	500	2000	" 15 ...	228	2450	" 18 ...	687	2911
" 24 ...	300	3000	" 22 ...	190	2430	" 25 ...	574	1690
" 31 ...	250	452	" 29 ...	85	660	Nov. 1 ...	682	3074
1860.			1861.			" 8 ...	770	3778
Jan. 7 ...	100	300	June 8 ...	172	132	" 15 ...	773	4212
" 14 ...	90	470	" 15 ...	195	97	" 22 ...	670	2730
" 21 ...	80	...	" 22 ...	260	12	" 29 ...	610	2399
" 28 ...	50	10	" 29 ...	454	161	Dec. 6 ...	400	432
Feb. 4 ...	35	15	July 6 ...	495	432	" 13 ...	500	2700
" 11 ...	30	23	" 13 ...	560	690	" 20 ...	450	961
" 18 ...	30	181	" 20 ...	600	764	" 27 ...	350	600
" 25 ...	50	505	" 27 ...	600	1019	27-31 ...	150	50
Mar. 3 ...	30	270	Aug. 3 ...	570	808	1863.		
" 10 ...	40	366	" 10 ...	565	1335	June 6 ...	85	6
" 17 ...	35	195	" 17 ...	565	1980	" 13 ...	195	85
" 24 ...	60	630	" 24 ...	565	400	" 20 ...	251	69
" 31 ...	60	294	" 31 ...	565	800	" 27 ...	340	215
April 7 ...	50	116	Sept. 7 ...	515	890	July 4 ...	458	608
" 14 ...	50	152	" 14 ...	515	890	" 11 ...	490	481
" 21 ...	40	75	" 21 ...	615	1215	" 18 ...	515	940
" 28 ...	30	45	" 28 ...	615	707	" 25 ...	541	1180
May 5 ...	30	141	Oct. 5 ...	550	431	Aug. 1 ...	539	918
" 12 ...	20	...	" 12 ...	570	532	" 8 ...	767	1733
" 19 ...	16	24	" 19 ...	470	672	" 15 ...	659	1450
" 26 ...	22	60	" 26 ...	450	325	" 22 ...	660	1466
June 2 ...	35	42	Nov. 2 ...	350	375	" 29 ...	719	1361
" 9 ...	95	68	" 9 ...	340	162	Sept. 5 ...	710	1122
" 16 ...	238	188	" 16 ...	340	29	" 12 ...	718	823½
" 23 ...	458	480	" 23 ...	310	72	" 19 ...	680	740
" 30 ...	450	320	" 30 ...	200	117	" 26 ...	630	957
July 7 ...	442	473	Dec. 7 ...	267	474	Oct. 3 ...	560	504
" 14 ...	470	807	" 14 ...	320	960	" 10 ...	487	1250
" 21 ...	550	947	" 21 ...	350	120	" 17 ...	650	1346
" 28 ...	550	999	" 28 ...	200	170	" 24 ...	716	1678
			28-31 ...	150	80	" 31 ...	605	1419

TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854-1906—*continued*.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1863.			1865.			1867.		
Nov. 7 ...	530	968	Sept. 2 ...	622	4209	June 8 ...	88	115
„ 14 ...	532	719	„ 9 ...	646	2361	„ 15 ...	152	229
„ 21 ...	460	693	„ 16 ...	552	3123	„ 22 ...	373	544
„ 28 ...	411	800	„ 23 ...	462	984	„ 29 ...	420	459
Dec. 5 ...	426	905	„ 30 ...	381	1426	July 6 ...	457	539
„ 12 ...	365	394	Oct. 7 ...	336	411½	„ 13 ...	436	1204
„ 19 ...	30	50	„ 14 ...	237	369	„ 20 ...	470	932
1864.			„ 21 ...	220	486	„ 27 ...	544	1325
June 4 ...	62	6	„ 28 ...	326	877	Aug. 3 ...	447	3352
„ 11 ...	242	51½	Nov. 4 ...	195	225	„ 10 ...	448	4320
„ 18 ...	345	234	„ 11 ...	290	395	„ 17 ...	401	1424
„ 25 ...	461	745	„ 18 ...	210	246	„ 24 ...	457	2160
July 2 ...	593	673½	„ 25 ...	45	18	„ 31 ...	470	2909
„ 9 ...	666	860	Dec. 2 ...	...	...	Sept. 7 ...	533	2114
„ 16 ...	682	1450	„ 9 ...	10	85	„ 14 ...	528	982
„ 23 ...	653	779	„ 16 ...	8	250	„ 21 ...	500	1467
„ 30 ...	550	873	1866.			„ 28 ...	466	1764
Aug. 6 ...	543	721	June 2 ...	24	4	Oct. 5 ...	340	611
„ 13 ...	516	486	„ 9 ...	155	99	„ 12 ...	320	989
„ 20 ...	541	366	„ 16 ...	250	181	„ 19 ...	310	451
„ 27 ...	520	1452	„ 23 ...	284	209	„ 26 ...	395	1050
Sept. 3 ...	482	554	„ 30 ...	375	362	Nov. 2 ...	127	755
„ 10 ...	433	240½	July 7 ...	525	692	„ 9 ...	125	391
„ 17 ...	563	1148½	„ 14 ...	425	380	„ 16 ...	130	435
„ 24 ...	558	605	„ 21 ...	428	524	„ 23 ...	174	1595
Oct. 1 ...	538	760½	„ 28 ...	603	748	„ 30 ...	180	1470
„ 8 ...	472	725	Aug. 4 ...	534	802	Dec. 7 ...	170	705
„ 15 ...	405	338	„ 11 ...	557	1459	„ 14 ...	140	855
„ 22 ...	300	279	„ 18 ...	543	2503	„ 21 ...	124	190
„ 29 ...	430	926	„ 25 ...	602	2340	„ 28 ...	145	530
Nov. 5 ...	240	551	Sept. 1 ...	568	1658	28-31 ...	125	160
„ 12 ...	121	526	„ 8 ...	598	2476	1868.		
„ 19 ...	60	226	„ 15 ...	478	909	Jan. 4 ...	135	525
„ 26 ...	50	112	„ 22 ...	550	1384	„ 11 ...	145	695
Dec. 3 ...	28	18	„ 29 ...	450	570	„ 18 ...	130	130
„ 10 ...	18	7	Oct. 6 ...	600	3260	„ 25 ...	125	1130
„ 17 ...	9	5	„ 13 ...	410	3696	Feb. 1 ...	45	50
1865.			„ 20 ...	490	1588	June 6 ...	193	590
June 3 ...	64	5	„ 27 ...	475	1203	„ 13 ...	233	814
„ 10 ...	149	66	Nov. 3 ...	375	1108	„ 20 ...	265	1189
„ 17 ...	297	152	„ 10 ...	200	239	„ 27 ...	275	800
„ 24 ...	355	122	„ 17 ...	175	215	July 4 ...	281	1476
July 1 ...	338	174	„ 24 ...	162	486	„ 11 ...	341	1963
„ 8 ...	479	562	Dec. 1 ...	155	510	„ 18 ...	351	2180
„ 15 ...	723	890	„ 8 ...	140	445	„ 25 ...	384	1910
„ 22 ...	628	1128	„ 15 ...	105	120	Aug. 1 ...	420	2575
„ 29 ...	635	908	„ 22 ...	113	130	„ 8 ...	406	2019
Aug. 5 ...	680	1343	„ 29 ...	103	80	„ 15 ...	444	2750
„ 12 ...	667	2967	1867.			„ 22 ...	462	2075
„ 19 ...	599	2240	Jan. 5 ...	90	217	„ 29 ...	420	896
„ 26 ...	628	2659	„ 12 ...	70	200			
			„ 19 ...	15	10			
			„ 26 ...	5	...			

TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854-1906—*continued*.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1868.			1870.			1871.		
Sept. 5 ...	479	2481	Jan. 1 ...	55	25	Sept. 2 ...	456	961
„ 12 ...	455	2307	„ 8 ...	80	145	„ 9 ...	437	334
„ 19 ...	450	3058	„ 15 ...	70	210	„ 16 ...	343	546
„ 26 ...	485	1981	„ 22 ...	85	320	„ 23 ...	363	544
			„ 29 ...	56	225	„ 30 ...	162	203
Oct. 3 ...	353	1084						
„ 10 ...	398	2019	June 4 ...	165	500	Oct. 7 ...	194	353
„ 17 ...	426	1363	„ 11 ...	229	895	„ 14 ...	256	1229
„ 24 ...	440	1445	„ 18 ...	254	609	„ 21 ...	327	700
„ 31 ...	205	210	„ 25 ...	312	1430	„ 28 ...	160	90
Nov. 7 ...	75	45	July 2 ...	357	1859	Nov. 4 ...	41	124
„ 14 ...	30	30	„ 9 ...	409	1549	„ 11 ...	70	160
„ 21 ...	32	45	„ 16 ...	455	1725	„ 18 ...	109	60
„ 28 ...	32	60	„ 23 ...	495	2405	„ 25 ...	41	80
			„ 30 ...	521	3006			
Dec. 5 ...	26	25				Dec. 2 ...	20	45
„ 12 ...	65	370	Aug. 6 ...	484	1950	„ 9 ...	18	40
„ 19 ...	75	510	„ 13 ...	616	1659	„ 16 ...	4	...
„ 26 ...	12	225	„ 20 ...	562	1943	„ 23 ...	6	...
1869.			„ 27 ...	562	2420	„ 30 ...	6	...
Jan. 2 ...	2	15						
„ 9 ...	36	560	Sept. 3 ...	681	1119			
„ 16 ...	72	140	„ 10 ...	512	696	1872.		
„ 23 ...	70	50	„ 17 ...	378	276	June 1 ...	101	70
„ 30 ...	4	4	„ 24 ...	445	1034	„ 8 ...	166	200
						„ 15 ...	207	235
June 5 ...	188	550	Oct. 1 ...	410	598	„ 22 ...	228	205
„ 12 ...	233	730	„ 8 ...	521	1494	„ 29 ...	245	291
„ 19 ...	250	1180	„ 15 ...	411	959			
„ 26 ...	317	2190	„ 22 ...	367	1045	July 6 ...	343	695
			„ 29 ...	307	729	„ 13 ...	419	640
July 3 ...	338	1580				„ 20 ...	481	1240
„ 10 ...	467	1035	Nov. 5 ...	393	1633	„ 27 ...	657	3220
„ 17 ...	417	1800	„ 12 ...	328	816			
„ 24 ...	504	2275	„ 19 ...	344	800	Aug. 3 ...	600	1286
„ 31 ...	565	1770	„ 26 ...	300	550	„ 10 ...	702	2062
						„ 17 ...	687	711
Aug. 7 ...	488	2355	Dec. 3 ...	215	325	„ 24 ...	728	1152
„ 14 ...	470	3588	„ 10 ...	80	80	„ 31 ...	589	1152
„ 21 ...	630	4107	„ 17 ...	39	25			
„ 28 ...	550	2566	„ 24 ...	23	170	Sept. 7 ...	497	1208
			„ 31 ...	31	195	„ 14 ...	349	598
Sept. 4 ...	458	4081	1871.			„ 21 ...	404	2327
„ 11 ...	464	2691	Jan. 7 ...	16	140	„ 28 ...	476	1353
„ 18 ...	438	1215	„ 14 ...	54	985			
„ 25 ...	399	588	„ 21 ...	50	500	Oct. 5 ...	450	595
			„ 28 ...	40	215	„ 12 ...	248	2146
Oct. 2 ...	381	941				„ 19 ...	69	40
„ 9 ...	452	2237	June 3 ...	127	230	„ 26 ...	18	8
„ 16 ...	400	1145	„ 10 ...	210	816			
„ 23 ...	135	302	„ 17 ...	304	730	Nov. 2 ...	7	5
„ 30 ...	36	95	„ 24 ...	450	1366	„ 9 ...	...	...
						„ 16 ...	87	430
Nov. 6 ...	16	245	July 1 ...	506	1417	„ 23 ...	240	950
„ 13 ...	10	10	„ 8 ...	504	1592	„ 30 ...	176	850
„ 20 ...	4	5	„ 15 ...	468	826			
„ 27 ...	...	...	„ 22 ...	640	752	Dec. 7 ...	256	700
			„ 29 ...	792	640	„ 14 ...	36	120
Dec. 4 ...	14	35						
„ 11 ...	32	135	Aug. 5 ...	666	730	1873.		
„ 18 ...	74	490	„ 12 ...	512	1018	June 7 ...	115	332
„ 25 ...	85	465	„ 19 ...	522	758	„ 14 ...	169	312
„ 31 ...	85	295	„ 26 ...	372	394	„ 21 ...	204	596
						„ 28 ...	239	516

TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854–1906—*continued*.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1873.			1875.			1876.		
July 5 ...	332	820	June 5 ...	70	153	Oct. 7 ...	254	456
„ 12 ...	365	874	„ 12 ...	132	119	„ 14 ...	250	520
„ 19 ...	372	1461	„ 19 ...	216	315	„ 21 ...	210	989
„ 26 ...	955	2444	„ 26 ...	266	558	„ 28 ...	420	5300
Aug. 2 ...	638	2494	July 3 ...	261	544	Nov. 4 ...	300	900
„ 9 ...	634	1014	„ 10 ...	362	1262	„ 11 ...	186	1758
„ 16 ...	449	909	„ 17 ...	340	1850	„ 18 ...	82	158
„ 23 ...	524	1568	„ 24 ...	312	1138	„ 25 ...	100	70
„ 30 ...	624	749	„ 31 ...	271	1998	Dec. 2 ...	46	617
Sept. 6 ...	438	896	Aug. 7 ...	388	2456	„ 9 ...	60	...
„ 13 ...	181	217	„ 14 ...	350	818	„ 16 ...	10	...
„ 20 ...	176	631	„ 21 ...	294	1047	„ 23 ...	...	...
„ 27 ...	302	1996	„ 28 ...	319	834	1877.		
Oct. 4 ...	293	792	Sept. 4 ...	302	319	Jan. 27 ...	2	...
„ 11 ...	43	143	„ 11 ...	270	300	June 2 ...	?	5
„ 18 ...	153	760	„ 18 ...	149	85	„ 9 ...	99	29
„ 25 ...	105	15	„ 25 ...	76	39	„ 16 ...	164	1638
Nov. 1 ...	55	...	Oct. 2 ...	114	47	„ 23 ...	222	1218
„ 8 ...	45	...	„ 9 ...	124	119	„ 30 ...	258	892
„ 15 ...	35	...	„ 16 ...	126	525	July 7 ...	287	1649
„ 22 ...	30	...	„ 23 ...	130	35	„ 14 ...	304	1347
„ 29 ...	20	...	„ 30 ...	166	525	„ 21 ...	301	2535
Dec. 6 ...	15	...	Nov. 7 ...	188	910	„ 28 ...	370	2204
1874.			„ 14 ...	93	110	Aug. 4 ...	550	3097
June 6 ...	92	186	„ 21 ...	96	165	„ 11 ...	574	3844
„ 13 ...	149	211	„ 28 ...	80	30	„ 18 ...	298	1976
„ 20 ...	223	771	Dec. 4 ...	65	115	„ 25 ...	413	1080
„ 27 ...	282	805	„ 11 ...	106	90	Sept. 1 ...	482	1569
July 4 ...	339	741	„ 18 ...	70	90	„ 8 ...	477	1665
„ 11 ...	480	2049	„ 25 ...	...	...	„ 15 ...	281	248
„ 18 ...	507	1941	„ 31 ...	10	5	„ 22 ...	382	1107
„ 25 ...	566	1016	1876.			„ 29 ...	375	2467
Aug. 1 ...	502	881	Jan. 15 ...	6	30	Oct. 6 ...	353	1629
„ 8 ...	669	887	„ 22 ...	4	...	„ 13 ...	376	210
„ 15 ...	480	671	June 3 ...	74	57	„ 20 ...	266	240
„ 22 ...	558	2416	„ 10 ...	112	344	„ 27 ...	134	180
„ 29 ...	373	662	„ 17 ...	196	511	Nov. 3 ...	70	660
Sept. 5 ...	277	1125	„ 24 ...	207	244	„ 10 ...	7	60
„ 12 ...	448	894	July 1 ...	303	752	„ 17 ...	48	150
„ 19 ...	414	1792	„ 8 ...	317	684	„ 24 ...	82	...
„ 26 ...	285	567	„ 15 ...	310	1686	Dec. 1 ...	70	...
Oct. 3 ...	354	263	„ 22 ...	310	1215	„ 8 ...	78	...
„ 10 ...	175	41	„ 29 ...	346	2824	„ 15 ...	10	...
„ 17 ...	157	555	Aug. 5 ...	345	2585	„ 22 ...	6	...
„ 24 ...	278	87	„ 12 ...	348	2396	„ 29 ...	...	...
„ 31 ...	64	1011	„ 19 ...	326	1186	1878.		
Nov. 7 ...	44	350	„ 26 ...	314	802	June 8 ...	151	413
„ 14 ...	98	269	Sept. 2 ...	395	968	„ 15 ...	219	1115
„ 21 ...	4	15	„ 9 ...	410	1216	„ 22 ...	256	773
„ 28 ...	...	...	„ 16 ...	390	544	„ 29 ...	321	1170
1875.			„ 23 ...	356	652	July 6 ...	382	1010
Jan. 23 ...	2	4	„ 30 ...	481	647	„ 13 ...	317	2608
„ 30 ...	4	6				„ 20 ...	333	2906
						„ 27 ...	298	1220

TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854–1906—continued.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1878.			1880.			1881.		
Aug. 3 ...	432	1875	June 5 ...	241	1080	Nov. 5 ...	238	1594
„ 10 ...	319	370	„ 12 ...	280	677	„ 12 ...	328	976
„ 17 ...	337	336	„ 19 ...	337	698	„ 19 ...	240	969
„ 24 ...	295	370	„ 26 ...	417	1692	„ 26 ...	220	1294
„ 31 ...	275	325	July 3 ...	470	3320	Dec. 3 ...	244	1094
Sept. 7 ...	211	334	„ 10 ...	470	5958	„ 10 ...	264	1166
„ 14 ...	176	50	„ 17 ...	332	3202	„ 17 ...	277	1673
„ 21 ...	5	...	„ 24 ...	320	3655	„ 24 ...	48	60
„ 28 ...	40	4	„ 31 ...	358	3456	„ 31 ...	...	...
Oct. 5 ...	...	...	Aug. 7 ...	440	4362	1882.		
„ 12 ...	...	...	„ 14 ...	390	2888	June 3 ...	228	468
„ 19 ...	12	14	„ 21 ...	355	786	„ 10 ...	440	942
„ 26 ...	24	10	„ 28 ...	297	1312	„ 17 ...	489	1234
Nov. 2 ...	6	...	Sept. 4 ...	244	941	„ 24 ...	677	3471
„ 9 ...	50	1240	„ 11 ...	395	578	July 1 ...	775	4799
„ 16 ...	50	350	„ 18 ...	302	396	„ 8 ...	636	4221
„ 23 ...	105	300	„ 25 ...	479	1896	„ 15 ...	824	5388
„ 30 ...	100	250	Oct. 2 ...	472	1207	„ 22 ...	617	4527
Dec. 7 ...	90	100	„ 9 ...	463	660	„ 29 ...	777	6139
„ 14 ...	8	30	„ 16 ...	531	543	Aug. 5 ...	624	3959
1879.			„ 23 ...	476	1500	„ 12 ...	536	5999
May 31 ...	94	276	„ 30 ...	426	1301	„ 19 ...	510	5819
June 7 ...	207	611	Nov. 6 ...	602	2100	„ 26 ...	461	5839
„ 14 ...	209	1324	„ 13 ...	430	2089	Sept. 2 ...	474	619
„ 21 ...	295	414	„ 20 ...	500	2496	„ 9 ...	513	3840
„ 28 ...	352	946	„ 27 ...	272	510	„ 16 ...	344	5242
July 5 ...	351	1075	Dec. 4 ...	462	2439	„ 23 ...	356	3156
„ 12 ...	374	1999	„ 11 ...	318	1359	„ 30 ...	341	1421
„ 19 ...	296	2005	„ 18 ...	118	1552	Oct. 7 ...	333	3406
„ 26 ...	342	2424	„ 25 ...	105	515	„ 14 ...	324	3351
Aug. 2 ...	332	3372	1881.			„ 21 ...	353	3294
„ 9 ...	397	3447	June 4 ...	234	489	„ 28 ...	365	8032
„ 16 ...	348	3780	„ 11 ...	311	2187	Nov. 4 ...	291	2640
„ 23 ...	298	2406	„ 18 ...	448	2037	„ 11 ...	295	3568
„ 30 ...	287	1557	„ 25 ...	564	1151	„ 18 ...	244	2205
Sept. 6 ...	323	2275	July 2 ...	494	2446	„ 25 ...	252	2327
„ 13 ...	304	1480	„ 9 ...	543	2005	Dec. 2 ...	209	684
„ 20 ...	322	1930	„ 16 ...	503	1950	„ 9 ...	80	18
„ 27 ...	320	1242	„ 23 ...	507	4471	„ 16 ...	16	6
Oct. 4 ...	344	1088	„ 30 ...	570	4066	1883.		
„ 11 ...	273	1103	Aug. 6 ...	593	3436	June 9 ...	360	630
„ 18 ...	263	3789	„ 13 ...	505	3104	„ 16 ...	561	828
„ 25 ...	300	3395	„ 20 ...	266	4725	„ 23 ...	616	2417
Nov. 1 ...	375	1667	„ 27 ...	586	2248	„ 30 ...	601	2696
„ 8 ...	647	4337	Sept. 3 ...	502	2189	July 7 ...	606	2528
„ 15 ...	588	2137	„ 10 ...	396	1234	„ 14 ...	616	4393
„ 22 ...	530	1515	„ 17 ...	383	1087	„ 21 ...	576	3325
„ 29 ...	167	60	„ 24 ...	159	939	„ 28 ...	581	4199
Dec. 6 ...	110	46	Oct. 1 ...	158	778	Aug. 4 ...	634	5359
„ 13 ...	82	75	„ 8 ...	150	76	„ 11 ...	527	2010
1880.			„ 15 ...	164	226	„ 18 ...	531	2815
May 29 ...	123	30	„ 22 ...	71	214	„ 25 ...	655	2062
			„ 29 ...	217	2172			



TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854–1906—*continued*.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1883.			1885.			1887.		
Sept. 1 ...	534	3086	Aug. 1 ...	506	1921	June 4 ...	270	764
" 8 ...	531	3396	" 8 ...	503	2329	" 11 ...	368	987
" 15 ...	390	2889	" 15 ...	508	2698	" 18 ...	472	1149
" 22 ...	319	1665	" 22 ...	390	4624	" 25 ...	562	1071
" 29 ...	319	2720	" 29 ...	469	2150			
						July 2 ...	578	869
Oct. 6 ...	351	7511	Sept. 5 ...	463	2558	" 9 ...	660	1298
" 13 ...	337	3876	" 12 ...	424	4071	" 16 ...	595	2049
" 20 ...	328	625	" 19 ...	524	6219	" 23 ...	544	3312
" 27 ...	317	1923	" 26 ...	140	121	" 30 ...	460	1033½
Nov. 3 ...	351	4663	Oct. 3 ...	313	4471	Aug. 6 ...	421	1807
" 10 ...	335	1564	" 10 ...	436	7814	" 13 ...	475	1812½
" 17 ...	339	1475	" 17 ...	419	494	" 20 ...	437	1213
" 24 ...	199	173	" 24 ...	350	976	" 27 ...	423	1174
			" 31 ...	182	3			
Dec. 1 ...	285	396				Sept. 3 ...	378	768
" 8 ...	157	1491	Nov. 7 ...	137	...	" 10 ...	419	1395½
" 15 ...	...	...	" 14 ...	12	...	" 17 ...	437	3599
" 22 ...	20	...				" 24 ...	440	6498
1884.			1886.			Oct. 1 ...	426	765
June 7 ...	292	1428	June 5 ...	402	1394	" 8 ...	404	1085
" 14 ...	440	712	" 12 ...	404	936	" 15 ...	272	398
" 21 ...	549	2055	" 19 ...	369	605	" 22 ...	400	2238
" 28 ...	658	2236	" 26 ...	524	2061	" 29 ...	414	366
July 5 ...	648	1709	July 3 ...	562	1869	Nov. 5 ...	562	3291
" 12 ...	614	1765	" 10 ...	474	1343	" 12 ...	834	7087
" 19 ...	620	1922	" 17 ...	508	1632	" 19 ...	382	42
" 26 ...	575	4336	" 24 ...	436	1193	" 26 ...	484	447
			" 31 ...	403	1234			
Aug. 2 ...	612	3301				Dec. 3 ...	560	1897
" 9 ...	614	2159	Aug. 7 ...	472	2168	" 10 ...	440	1229
" 16 ...	488	2511	" 14 ...	496	1915	" 17 ...	280	17
" 23 ...	460	3194	" 21 ...	484	2243	" 24 ...	520	992
" 30 ...	410	2939	" 28 ...	475	2940			
Sept. 6 ...	349	288	Sept. 4 ...	388	2997	1888.		
" 13 ...	367	866	" 11 ...	290	105	June 9 ...	252	38
" 20 ...	326	1087	" 18 ...	232	619	" 16 ...	331	294
" 27 ...	330	401	" 25 ...	293	339	" 23 ...	374	300
						" 30 ...	537	1183
Oct. 4 ...	340	384	Oct. 2 ...	342	645	July 7 ...	631	2743
" 11 ...	186	1262	" 9 ...	353	363	" 14 ...	625	2526
" 18 ...	414	3998	" 16 ...	278	209	" 21 ...	562	3870
" 25 ...	400	4592	" 23 ...	479	758	" 28 ...	567	2698
			" 30 ...	394	977			
Nov. 1 ...	379	24				Aug. 4 ...	388	3920
" 8 ...	120	812	Nov. 6 ...	272	360	" 11 ...	382	3430
" 15 ...	229	3006	" 13 ...	254	569	" 18 ...	401	3739
" 22 ...	156	410	" 20 ...	364	600	" 25 ...	492	1461
" 29 ...	72	165	" 27 ...	530	1761			
1885.			Dec. 4 ...	275	2448	Sept. 1 ...	528	2439
June 6 ...	328	2226	" 11 ...	20	135	" 8 ...	444	1150½
" 13 ...	415	2699	" 18 ...	315	5350	" 15 ...	450	2136½
" 20 ...	526	2001				" 22 ...	374	164½
" 27 ...	511	2789				" 29 ...	186	746½
July 4 ...	618	2978	1887.			Oct. 6 ...	356	1269½
" 11 ...	580	2733	May 7 ...	118	525	" 13 ...	377	2553½
" 18 ...	594	4166	" 14 ...	126	90	" 20 ...	430	1639
" 25 ...	528	3285	" 21 ...	136	34	" 27 ...	385	333
			" 28 ...	162	383			

TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854-1906—continued.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1888.			1890.			1892.		
Nov. 3 ...	388	1465	Sept. 6 ...	103	882½	July 2 ...	489	2470
" 10 ...	120	...	" 13 ...	103	1501½	" 9 ...	469	3156
" 17 ...	328	908	" 20 ...	188	1161½	" 16 ...	442	3195
" 24 ...	202	146	" 27 ...	88	276	" 23 ...	580	6017½
						" 30 ...	406	5993½
Dec. 1 ...	362	2842	Oct. 4 ...	346	47½	Aug. 6 ...	289	5397½
" 8 ...	364	1797	" 11 ...	345	971	" 13 ...	283	2654½
" 15 ...	476	2388	" 18 ...	328	810	" 20 ...	276	2538
" 22 ...	380	2307	" 25 ...	424	4019	" 27 ...	262	2544½
" 29 ...	180	250						
1889.			Nov. 1 ...	448	381	Sept. 3 ...	255	1723
June 8 ...	344	691½	" 8 ...	512	5130	" 10 ...	269	2298½
" 15 ...	433	946½	" 15 ...	421	394	" 17 ...	266	1663
" 22 ...	252	804	" 22 ...	450	1575	" 24 ...	273	2059
" 29 ...	368	957	" 29 ...	407	1417			
July 6 ...	413	1340	Dec. 6 ...	303	1356	Oct. 1 ...	254	700
" 13 ...	355	2653	" 13 ...	259	1336	" 8 ...	280	1637
" 20 ...	368	3209½	" 20 ...	149	1595	" 15 ...	332	1358
" 27 ...	339	2282	" 27 ...	268	1059	" 22 ...	368	1753
			1891.			" 29 ...	368	487
Aug. 3 ...	267	1961½	June 6 ...	303	850			
" 10 ...	270	1275½	" 13 ...	409	1800	Nov. 5 ...	290	704
" 17 ...	218	1045½	" 20 ...	441	1950	" 12 ...	330	1336
" 24 ...	248	1016	" 27 ...	507	1678	" 19 ...	328	231
" 31 ...	247	2588½				" 26 ...	334	1290
			July 4 ...	468	3392	Dec. 3 ...	310	400
Sept. 7 ...	217	1082½	" 11 ...	502	4631	" 10 ...	320	1166
" 14 ...	208	237½	" 18 ...	431	3936	" 17 ...	300	2751
" 21 ...	100	1029	" 25 ...	393	3295	" 24 ...	260	2000
" 28 ...	273	3886½				" 31 ...	240	1000
			Aug. 1 ...	383	5005			
Oct. 5 ...	249	4514	" 8 ...	270	2009½	1893.		
" 12 ...	252	2832	" 15 ...	281	1640½	June 3 ...	56	69
" 19 ...	340	3024	" 22 ...	283	1288	" 10 ...	477	1353
" 26 ...	323	3876	" 29 ...	252	1254½	" 17 ...	492	821
						" 24 ...	536	1264
Nov. 2 ...	355	1451	Sept. 5 ...	242	547			
" 9 ...	344	2245	" 12 ...	216	1088½	July 1 ...	518	2255
" 16 ...	361	2741	" 19 ...	212	988½	" 8 ...	540	3137
" 23 ...	412	5388	" 26 ...	228	1161	" 15 ...	472	4683½
" 30 ...	331	224				" 22 ...	424	3999
			Oct. 3 ...	232	879	" 29 ...	372	4765
Dec. 7 ...	202	44	" 10 ...	264	894½			
" 14 ...	283	930	" 17 ...	271	1263	Aug. 5 ...	335	3458½
" 21 ...	132	939	" 24 ...	354	4390	" 12 ...	258	3851½
" 28 ...	88	23	" 31 ...	420	3201	" 19 ...	287	2543½
1890.						" 26 ...	236	713
June 7 ...	378	183	Nov. 7 ...	373	5220			
" 14 ...	462	254	" 14 ...	322	324	Sept. 2 ...	267	1576
" 21 ...	551	659	" 21 ...	298	1633	" 9 ...	282	1138½
" 28 ...	626	1997	" 28 ...	294	4120	" 16 ...	265	686½
						" 23 ...	236	511½
July 5 ...	556	3268	Dec. 5 ...	266	958	" 30 ...	236	364
" 12 ...	557	4276	" 12 ...	261	1471			
" 19 ...	650	3679½	" 19 ...	261	1015	Oct. 7 ...	216	103
" 26 ...	380	1682	" 26 ...	261	2240	" 14 ...	210	17
			" 26-31 ...	261	2253	" 21 ...	210	152
			1892.			" 28 ...	210	436
Aug. 2 ...	218	2924½	June 4 ...	54	54	Nov. 4 ...	210	1870
" 9 ...	288	2671	" 11 ...	332	1505	" 11 ...	220	800
" 16 ...	264	3384	" 18 ...	397	1140	" 18 ...	210	897
" 23 ...	263	1551	" 25 ...	455	2157	" 25 ...	210	345
" 30 ...	242	804½						

TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854–1906—continued.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1893.			1895.			1897.		
Dec. 2 ...	192	504	Oct. 5 ...	48	32	Aug. 7 ...	439	3386
" 9 ...	192	412	" 12 ...	49	84	" 14 ...	425	4066
" 16 ...	169	1000	" 19 ...	28	69	" 21 ...	404	3338
" 23 ...	171	1065	" 26 ...	22	46½	" 28 ...	343	3628
" 30 ...	211	2139						
1894.			Nov. 2 ...	46	48½	Sept. 4 ...	446	5238
June 9 ...	231	1582	" 9 ...	168	150	" 11 ...	445	7435
" 16 ...	330	2159	" 16 ...	157	191	" 18 ...	399	4314
" 23 ...	389	1949½	" 23 ...	154	1071	" 25 ...	396	4595
" 30 ...	409	5202½	" 30 ...	174	506			
July 7 ...	381	3313½	Dec. 7 ...	150	227	Oct. 2 ...	385	3319
" 14 ...	396	5277	" 14 ...	168	869	" 9 ...	331	4232
" 21 ...	396	1950	" 21 ...	178	245	" 16 ...	234	984
" 28 ...	380	4254	" 28 ...	22	77	" 23 ...	262	2523
			1896.			" 30 ...	239	2283
Aug. 4 ...	426	4964	June 6 ...	247	496	Nov. 6 ...	251	1279
" 11 ...	405	2352	" 13 ...	325	530	" 13 ...	251	965
" 18 ...	458	1625½	" 20 ...	408	911	" 20 ...	334	1179
" 25 ...	445	3093	" 27 ...	408	1684	" 27 ...	324	3277
Sept. 1 ...	450	2189	July 4 ...	378	2213	Dec. 4 ...	286	2047
" 8 ...	342	1306	" 11 ...	414	1644	" 11 ...	6	70
" 15 ...	325	778½	" 18 ...	462	1322	" 18 ...	225	1784
" 22 ...	345	1286	" 25 ...	444	1224	" 25 ...	243	1326
" 29 ...	300	1671				" 31 ...	107	400
Oct. 6 ...	263	915½	Aug. 1 ...	487	851	1898.		
" 13 ...	160	146	" 8 ...	416	2215	June 4 ...	223	673
" 20 ...	150	463½	" 15 ...	415	906	" 11 ...	350	1518
" 17 ...	136	59	" 22 ...	359	1471	" 18 ...	370	1898
			" 29 ...	403	1103	" 25 ...	378	2770
Nov. 3 ...	106	24	Sept. 5 ...	441	1308	July 2 ...	368	3814
" 10 ...	80	43	" 12 ...	381	960	" 9 ...	368	4210
" 17 ...	210	510	" 19 ...	171	419	" 16 ...	377	2714
" 24 ...	209	170	" 26 ...	217	736	" 23 ...	439	5431
Dec. 1 ...	215	2357	Oct. 3 ...	266	2766	" 30 ...	397	4218
" 8 ...	258	1991	" 10 ...	239	854	Aug. 6 ...	423	2151
" 15 ...	216	2229	" 17 ...	218	442	" 13 ...	417	2379
" 22 ...	170	1658	" 24 ...	102	55	" 20 ...	490	2640
" 29 ...	130	1573	" 31 ...	205	745	" 27 ...	436	3505
1895.								
June 8 ...	280	502½	Nov. 7 ...	209	1568	Sept. 3 ...	408	1244
" 15 ...	358	843½	" 14 ...	198	189	" 10 ...	462	2255
" 22 ...	404	732	" 21 ...	168	427	" 17 ...	497	1926
" 29 ...	449	1635	" 28 ...	148	718	" 24 ...	326	2341
July 6 ...	475	2885½	Dec. 5 ...	144	154	Oct. 1 ...	313	705
" 13 ...	516	2123	" 12 ...	136	101	" 8 ...	252	1649
" 20 ...	497	2192½	" 19 ...	132	243	" 15 ...	292	1320
" 27 ...	350	1584½	" 26 ...	63	198	" 22 ...	289	390
			1897.			" 29 ...	270	509
Aug. 3 ...	476	2999	June 5 ...	171	372	Nov. 5 ...	243	663
" 10 ...	456	1960½	" 12 ...	232	823	" 12 ...	270	1439
" 17 ...	419	1452½	" 19 ...	281	240	" 19 ...	270	968
" 24 ...	292	394½	" 26 ...	367	1109	" 26 ...	333	2823
" 31 ...	304	778½						
Sept. 7 ...	289	965	July 3 ...	408	2795	Dec. 3 ...	211	2645
" 14 ...	304	532	" 10 ...	419	2377	" 10 ...	171	1419
" 21 ...	194	137	" 17 ...	424	3081	" 17 ...	219	1342
" 28 ...	117	80	" 24 ...	433	3456	" 24 ...	188	1229
			" 31 ...	413	3859	" 31 ...	36	278

TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854–1906—continued.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1899.			1900.			1902.		
June 3 ...	72	209	Oct. 6 ...	330	3049	July 5 ...	370	3725
" 10 ...	259	1744	" 13 ...	250	302	" 12 ...	370	2289
" 17 ...	296	1738	" 20 ...	330	1652	" 19 ...	375	4313
" 24 ...	329	1005	" 27 ...	310	634	" 26 ...	360	3185
July 1 ...	354	2576	Nov. 3 ...	274	943	Aug. 2 ...	390	4841
" 8 ...	350	3086	" 10 ...	300	88	" 9 ...	400	4096
" 15 ...	316	4292	" 17 ...	280	561	" 16 ...	390	5527
" 22 ...	373	4159	" 24 ...	270	639	" 23 ...	410	2786
" 29 ...	376	3064	Dec. 1 ...	260	50	" 30 ...	410	4970
Aug. 5 ...	378	5063	" 8 ...	284	1741	Sept. 6 ...	410	3125
" 12 ...	378	4701	" 15 ...	150	—	" 13 ...	410	3955
" 19 ...	438	3396	" 22 ...	120	33	" 20 ...	280	790
" 26 ...	332	1024				" 27 ...	320	402
Sept. 2 ...	307	2328	1901.			Oct. 4 ...	300	820
" 9 ...	308	1481	May 25 ...	140	38	" 11 ...	130	1399
" 16 ...	347	4296	June 1 ...	150	184	" 18 ...	210	204
" 23 ...	150	1184	" 8 ...	325	1444	" 25 ...	150	866
" 30 ...	315	2073	" 15 ...	345	790	Nov. 1 ...	150	1087
Oct. 7 ...	191	852	" 22 ...	350	1548	" 8 ...	150	1134
" 14 ...	265	1508	" 29 ...	365	2875	" 15 ...	?	517
" 21 ...	193	360	July 6 ...	360	3230	" 22 ...	162	498
" 28 ...	193	459	" 13 ...	360	1984	" 29 ...	160	394
Nov. 4 ...	230	1079	" 20 ...	350	2747	Dec. 6 ...	162	235
" 11 ...	230	445	" 27 ...	330	4268	" 13 ...	152	286
" 18 ...	290	655	Aug. 3 ...	340	2267	" 20 ...	150	1304
" 25 ...	308	3303	" 10 ...	390	3420	" 27 ...	200	695
Dec. 2 ...	300	1033	" 17 ...	330	3418	" 27–31 ...	190	1285
" 9 ...	220	644	" 24 ...	410	5785			
" 16 ...	200	1809	" 31 ...	320	1248	1903.		
" 23 ...	170	147	Sept. 7 ...	330	3338	June 6 ...	350	686
" 30 ...	50	178	" 14 ...	380	4104	" 13 ...	320	841
1900.			" 21 ...	310	1398	" 20 ...	360	1190
June 2 ...	280	497	" 28 ...	350	1578	" 27 ...	340	1328
" 9 ...	328	1583	Oct. 5 ...	300	1529	July 4 ...	340	1747
" 16 ...	305	818	" 12 ...	300	386	" 11 ...	331	4390
" 23 ...	320	2327	" 19 ...	230	154	" 18 ...	345	3948
" 30 ...	348	2819	" 26 ...	210	50	" 25 ...	341	4248
July 7 ...	348	2976	Nov. 2 ...	120	140	Aug. 1 ...	355	4058
" 14 ...	328	2828	" 9 ...	130	34	" 8 ...	360	2868
" 21 ...	326	5690	" 16 ...	140	400	" 15 ...	370	3364
" 28 ...	338	2991	" 23 ...	190	382	" 22 ...	370	3526
Aug. 4 ...	340	2303	" 30 ...	278	1008	" 29 ...	375	2516
" 11 ...	350	4338	Dec. 7 ...	260	1490	Sept. 5 ...	375	2066
" 18 ...	380	3450	" 14 ...	265	341	" 12 ...	346	1239
" 25 ...	324	4244	" 21 ...	240	1773	" 19 ...	315	2221
Sept. 1 ...	340	2343	" 28 ...	190	918	" 26 ...	290	1679
" 8 ...	350	2993	1902.			Oct. 3 ...	246	609
" 15 ...	330	3013	June 7 ...	360	1115	" 10 ...	170	123
" 22 ...	380	2629	" 14 ...	310	1846	" 17 ...	140	515
" 29 ...	330	3759	" 21 ...	340	1594	" 24 ...	176	30
			" 28 ...	360	1191	" 31 ...	144	—

TABLE XXIII.—Weekly Returns of Boats Fishing and Herrings Landed in Inveraray and Campbeltown Districts, 1854–1906—continued.

Week ended	Boats.	Crans.	Week ended	Boats.	Crans.	Week ended	Boats.	Crans.
1903.			1904.			1906.		
Nov. 7 ...	160	48	Dec. 3 ...	162	14	May 5 ...	40	44
" 14 ...	142	—	" 10 ...	138	46	" 12 ...	70	86
" 21 ...	100	—	" 17 ...	150	—	" 19 ...	100	74
" 28 ...	210	335	" 24 ...	240	527	" 26 ...	120	188
			" 31 ...	240	322			
Dec. 5 ...	220	902				June 2 ...	120	130
" 12 ...	224	164	1905.			" 9 ...	180	696
" 19 ...	230	265	May 6 ...	60	134	" 16 ...	240	1513
" 26 ...	246	1480	" 13 ...	110	360	" 23 ...	250	1181
" 26–31...	184	132	" 20 ...	120	398	" 30 ...	256	708
			" 27 ...	130	78			
1904.			June 3 ...	230	266	July 7 ...	264	1059
May 7 ...	65	17	" 10 ...	150	1158	" 14 ...	280	1005
" 14 ...	70	8	" 17 ...	152	545	" 21 ...	280	692
" 21 ...	90	63	" 24 ...	237	901	" 28 ...	300	1752
" 28 ...	120	164	July 1 ...	247	528			
June 4 ...	280	720	" 8 ...	330	1336	Aug. 4 ...	330	258
" 11 ...	303	518	" 15 ...	325	1584	" 11 ...	310	386
" 18 ...	294	524	" 22 ...	320	2147	" 18 ...	140	66
" 25 ...	304	1046	" 29 ...	320	3110	" 25 ...	70	17
July 2 ...	314	550	Aug. 5 ...	300	1806	Sept. 1 ...	40	100
" 9 ...	340	769	" 12 ...	350	1765	" 8 ...	10	1
" 16 ...	340	979	" 19 ...	350	1319	" 15 ...	20	47
" 23 ...	340	2057	" 26 ...	320	456	" 22 ...	58	285
" 30 ...	310	1145	Sept. 2 ...	100	156	" 29 ...	100	445
Aug. 6 ...	330	1021	" 9 ...	100	36			
" 13 ...	355	1135	" 16 ...	80	7	Oct. 6 ...	150	1235
" 20 ...	355	815	" 23 ...	72	165	" 13 ...	150	252
" 27 ...	360	685	" 30 ...	85	8	" 20 ...	150	2
Sept. 3 ...	340	451	Oct. 7 ...	100	124	" 27 ...	2	—
" 10 ...	320	143	" 14 ...	120	153			
" 17 ...	290	424	" 21 ...	160	32	Nov. 3 ...	10	—
" 24 ...	200	295	" 28 ...	100	51	" 10 ...	30	255
Oct. 1 ...	280	121	Nov. 4 ...	100	21	" 17 ...	8	—
" 8 ...	200	45	" 11 ...	90	100	" 24 ...	8	—
" 15 ...	180	103	" 18 ...	98	44			
" 22 ...	190	47	" 25 ...	100	100	Dec. 1 ...	4	—
" 29 ...	100	36	Dec. 2 ...	110	292	" 8 ...	8	—
Nov. 5 ...	10	—	" 9 ...	118	17	" 15 ...	4	5
" 12 ...	66	—	" 16 ...	130	933	" 22 ...	—	—
" 19 ...	116	—	" 23 ...	110	58	" 29 ...	4	50
" 26 ...	52	2	" 30 ...	60	—			

TABLE XXIV., Showing the Relation of the Phase of the Moon to the Catch of Herrings in Loch Fyne, 1860-1900.

New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.	New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.
1860.				1863.			
Jan. 23...	10	Jan. 8...	470	Jan. 19...	...	Jan. 5...	...
Feb. 21...	505	Feb. 7...	23	Feb. 18...	...	Feb. 3...	...
Mar. 22...	630	Mar. 7...	366	Mar. 19...	...	Mar. 5...	...
Apr. 21...	75	Apr. 5...	116	Apr. 18...	...	Apr. 4...	...
May 20...	60	May 5...	141	May 17...	...	May 3...	...
June 19...	480	June 3...	68	June 16...	39	June 1...	6
July 18...	947	July 3...	473	July 15...	513	July 1...	82
Aug. 16...	600	Aug. 1...	680			July 30...	751
		Aug. 31...	450	Aug. 14...	1443	Aug. 28...	1354
Sep. 15...	320	Sep. 30...	800	Sep. 13...	740	Sep. 27...	504
Oct. 14...	1500	Oct. 29...	2600	Oct. 12...	1346	Oct. 26...	1419
Nov. 13...	1930	Nov. 28...	110	Nov. 11...	719	Nov. 25...	800
Dec. 12...	2450	Dec. 28...	660	Dec. 10...	394	Dec. 25...	...
Total	9507	Total	6957	Total	5194	Total	4916
1861.				1864.			
Jan. 11...	...	Jan. 26...	...	Jan. 9...	...	Jan. 23...	...
Feb. 9...	...	Feb. 25...	...	Feb. 7...	...	Feb. 22...	...
Mar. 11...	...	Mar. 26...	...	Mar. 8...	...	Mar. 23...	...
Apr. 10...	...	Apr. 24...	...	Apr. 6...	...	Apr. 22...	...
May 9...	...	May 24...	...	May 6...	...	May 21...	...
June 8...	132	June 22...	12	June 4...	6	June 19...	400
July 8...	690	July 22...	1019	July 4...	335	July 19...	572
Aug. 6...	1335	Aug. 20...	400	Aug. 2...	618	Aug. 17...	279
Sep. 4...	890	Sep. 19...	1215	Sep. 1...	540	Sep. 15...	1120
Oct. 4...	431	Oct. 18...	672	Sep. 30...	755		
Nov. 2...	375	Nov. 17...	72	Oct. 30...	511	Oct. 15...	338
Dec. 2...	474	Dec. 17...	120	Nov. 29...	18	Nov. 13...	226
Dec. 31...	80			Dec. 28...	...	Dec. 13...	5
Total	4407	Total	3510	Total	2783	Total	2940
1862.				1865.			
Jan. 30...	...	Jan. 16...	...	Jan. 27...	...	Jan. 11...	...
Feb. 28...	...	Feb. 14...	...	Feb. 25...	...	Feb. 10...	...
Mar. 30...	...	Mar. 16...	...	Mar. 27...	...	Mar. 12...	...
Apr. 28...	...	Apr. 14...	...	Apr. 25...	...	Apr. 11...	...
May 28...	...	May 13...	...	May 24...	...	May 10...	...
June 27...	102	June 12...	2	June 23...	42	June 9...	16
July 26...	1021	July 11...	149	July 22...	1007	July 8...	142
Aug. 25...	3435	Aug. 9...	2020	Aug. 21...	2520	Aug. 7...	2683
Sep. 23...	3810	Sep. 8...	2275	Sep. 19...	980	Sep. 5...	2356
Oct. 23...	1690	Oct. 7...	3725	Oct. 19...	486	Oct. 4...	410
Nov. 21...	2730	Nov. 6...	3778	Nov. 18...	246	Nov. 3...	225
Dec. 21...	600	Dec. 6...	432	Dec. 18...	...	Dec. 2...	...
Total	13288	Total	12381	Total	5281	Total	5832

\* The catch for the whole week in which the new or full moon appeared is given in each case.

TABLE XXIV., Showing the Relation of the Phase of the Moon to the Catch of Herrings in Loch Fyne, 1860-1900—continued.

New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.	New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.
1866.				1869.			
Jan. 16...	...	Jan. 1...	...	Jan. 12...	140	Jan. 28...	4
Feb. 15...	...	Jan. 29...	...	Feb. 11...	...	Feb. 26...	...
Mar. 16...	...	Mar. 1...	...	Mar. 13...	...	Mar. 27...	...
Apr. 15...	...	Mar. 31...	...	Apr. 12...	...	Apr. 26...	...
May 14...	...	Apr. 29...	...	May 11...	...	May 25...	...
June 12...	73	May 29...	...	June 10...	530	June 24...	1610
July 12...	234	June 28...	240	July 9...	780	July 23...	1705
Aug. 10...	1270	July 27...	617	Aug. 7...	1849	Aug. 22...	1509
Sep. 9...	908	Aug. 26...	1585	Sep. 6...	2456	Sept. 20...	579
Oct. 8...	3696	Sep. 24...	570	Oct. 5...	2158	Oct. 20...	302
Nov. 7...	239	Oct. 24...	1203	Nov. 3...	245	Nov. 19...	5
Dec. 7...	445	Nov. 22...	486	Dec. 3...	35	Dec. 18...	490
Dec. 21...		Dec. 21...	130	Total	8193	Total	6204
Total	6865	Total	4831	1870.			
1867.				Jan. 2...	145	Jan. 17...	320
Jan. 6...	200	Jan. 20...	...	Jan. 31...	...	Feb. 16...	...
Feb. 4...	...	Feb. 18...	...	Mar. 2...	...	Mar. 17...	...
Mar. 6...	...	Mar. 20...	...	Apr. 1...	...	Apr. 15...	...
Apr. 4...	...	Apr. 18...	...	Apr. 30...	...	May 15...	...
May 4...	...	May 18...	...	May 30...	...	June 13...	305
June 2...	55	June 17...	260	June 28...	895	July 12...	1190
July 1...	295	July 16...	788	July 28...	2417	Aug. 11...	800
July 31...	3096	Aug. 15...	1316	Aug. 26...	1778	Sep. 9...	544
Aug. 29...	2810	Sep. 14...	981	Sep. 25...	3089	Oct. 9...	939
Sep. 27...	1764	Oct. 13...	451	Oct. 24...	725	Nov. 8...	740
Oct. 27...	755	Nov. 12...	435	Nov. 23...	550	Dec. 8...	80
Nov. 26...	1470	Dec. 11...	855	Dec. 22...	170	Total	4918
Dec. 25...	160	Total	5086	Total	9769	Total	4918
Total	10605	Total	5086	1871.			
1868.				Jan. 21...	500	Jan. 6...	140
Jan. 24...	1130	Jan. 9...	695	Feb. 19...	...	Feb. 5...	...
Feb. 23...	...	Feb. 8...	...	Mar. 21...	...	Mar. 7...	...
Mar. 24...	...	Mar. 8...	...	Apr. 19...	...	Apr. 5...	...
Apr. 22...	...	Apr. 7...	...	May 19...	...	May 4...	...
May 22...	...	May 6...	...	June 18...	865	June 3...	230
June 20...	1045	June 5...	530	July 17...	400	July 2...	1325
July 19...	1800	July 4...	1285	Aug. 16...	410	July 31...	249
Aug. 18...	1920	Aug. 3...	1955	Sep. 14...	213	Aug. 30...	820
Sep. 16...	3058	Sep. 2...	2179	Oct. 14...	1035	Sep. 28...	101
Oct. 15...	1363	Oct. 1...	1084	Nov. 12...	60	Oct. 28...	90
Nov. 14...	30	Oct. 31...	210	Dec. 12...	...	Nov. 27...	45
Dec. 14...	510	Nov. 30...	25	Dec. 26...	...	Dec. 26...	...
Dec. 29...		Dec. 29...	...	Total	3483	Total	3000
Total	10856	Total	7963	Total	3483	Total	3000

\* The catch for the whole week in which the new or full moon appeared is given in each case.

TABLE XXIV., Showing the Relation of the Phase of the Moon to the Catch of Herrings in Loch Fyne, 1860-1900—continued.

New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.	New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.
1872.				1875.			
Jan. 10...	...	Jan. 25...	...	Jan. 7...	...	Jan. 21...	4
Feb. 9...	...	Feb. 24...	...	Feb. 6...	...	Feb. 20...	...
Mar. 9...	...	Mar. 25...	...	Mar. 7...	...	Mar. 21...	...
Apr. 8...	...	Apr. 23...	...	Apr. 6...	...	Apr. 20...	...
May 7...	...	May 22...	...	May 5...	...	May 20...	...
June 6...	163	June 21...	139	June 3...	95	June 18...	225
July 5...	195	July 20...	300	July 3...	340	July 18...	1020
Aug. 4...	343	Aug. 18...	507	Aug. 1...	1850	Aug. 17...	915
Sep. 3...	335	Sep. 17...	315	Aug. 30...	203	...	...
Oct. 2...	365	Oct. 16...	30	Sept. 29...	49	Sept. 15...	15
Nov. 1...	5	Nov. 8...	...	Oct. 29...	525	Oct. 14...	525
Nov. 30...	850	...	...	Nov. 27...	30	Nov. 13...	110
Dec. 30...	...	Dec. 14...	120	Dec. 27...	5	Dec. 12...	90
Total	2256	Total	1411	Total	3097	Total	2904
1873.				1876.			
Jan. 28...	...	Jan. 13...	...	Jan. 26...	...	Jan. 11...	30
Feb. 27...	...	Feb. 12...	...	Feb. 25...	...	Feb. 9...	...
Mar. 28...	...	Mar. 14...	...	Mar. 25...	...	Mar. 10...	...
Apr. 26...	...	Apr. 12...	...	Apr. 24...	...	Apr. 8...	...
May 26...	...	May 12...	...	May 23...	...	May 8...	...
June 24...	310	June 10...	125	June 21...	162	June 7...	48
July 24...	263	July 10...	370	July 21...	910	July 6...	445
Aug. 23...	16	Aug. 8...	13	Aug. 19...	609	Aug. 5...	1222
Sept. 21...	36	Sept. 6...	52	Sept. 17...	429	Sept. 3...	622
Oct. 21...	...	Oct. 6...	94	Oct. 17...	989	Oct. 3...	436
Nov. 20...	...	Nov. 4...	...	Nov. 16...	158	Nov. 1...	900
Dec. 19...	...	Dec. 4...	...	Dec. 15...	...	Dec. 1...	617
						Dec. 30...	...
Total	625	Total	654	Total	3257	Total	4320
1874.				1877.			
Jan. 18...	...	Jan. 2...	...	Jan. 14...	...	Jan. 29...	...
Feb. 16...	...	Feb. 1...	...	Feb. 13...	...	Feb. 27...	...
Mar. 18...	...	Mar. 3...	...	Mar. 15...	...	Mar. 29...	...
Apr. 16...	...	Apr. 1...	...	Apr. 13...	...	Apr. 27...	...
May 15...	...	May 1...	...	May 13...	...	May 27...	...
June 14...	75	June 29...	260	June 11...	24	June 25...	600
July 13...	275	July 29...	228	July 10...	897	July 25...	702
Aug. 12...	98	Aug. 27...	301	Aug. 9...	1735	Aug. 23...	423
Sept. 10...	368	Sept. 25...	359	Sept. 7...	1371	Sept. 22...	697
Oct. 10...	30	Oct. 25...	170	Oct. 6...	1587	Oct. 22...	180
Nov. 9...	2	Nov. 23...	...	Nov. 5...	60	Nov. 20...	...
Dec. 9...	...	Dec. 23...	...	Dec. 4...	...	Dec. 20...	...
Total	848	Total	1318	Total	5674	Total	2602

\* The catch for the whole week in which the new or full moon appeared is given in each case.



TABLE XXIV., Showing the Relation of the Phase of the Moon to the Catch of Herrings in Loch Fyne, 1860-1900—continued.

New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.	New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.
1878.				1881.			
Jan. 3...	...	Jan. 19...	...	Jan. 30...	...	Jan. 15...	...
Feb. 2...	...	Feb. 17...	...	Feb. 28...	...	Feb. 14...	...
Mar. 4...	...	Mar. 18...	...	Mar. 29...	...	Mar. 15...	...
Apr. 2...	...	Apr. 17...	...	Apr. 28...	...	Apr. 14...	...
May. 2...	...	May 16...	...	May 27...	...	May 13...	...
June 1...	...	June 14...	322	June 26...	1135	June 12...	1165
June 31...	650			July 26...	2536	July 11...	186
July 29...	972	July 14...	1465	Aug. 24...	1331	Aug. 9...	1968
Aug. 28...	57	Aug. 13...	47	Sept 23...	883	Sept. 8...	1121
Sept. 26...	4	Sept. 11...	37	Oct. 23...	1750	Oct. 7...	60
Oct. 25...	10	Oct. 11...	...	Nov. 21...	960	Nov. 6...	600
Nov. 24...	250	Nov. 10...	350	Dec. 21...	...	Dec. 5...	400
Dec. 23...	...	Dec. 9...	30				
Total	1943	Total	2251	Total	8595	Total	5500
1879.				1882.			
Jan. 22...	...	Jan. 8...	...	Jan. 19...	...	Jan. 4...	...
Feb. 21...	...	Feb. 7...	...	Feb. 18...	...	Feb. 3...	...
Mar. 22...	...	Mar. 9...	...	Mar. 19...	...	Mar. 5...	...
Apr. 21...	...	Apr. 6...	...	Apr. 17...	...	Apr. 3...	...
May 21...	...	May 6...	...	May 17...	...	May 3...	...
June 19...	275	June 4...	393	June 15...	45	June 1...	23
July 19...	980	July 3...	814	July 15...	1784	July 1...	3585
Aug. 17...	1963	Aug. 2...	2076	Aug. 13...	3370	July 30...	1780
		Aug. 31...	1304	Sept. 12...	2502	Aug. 28...	313
Sept. 16...	726	Sept. 30...	201	Oct. 12...	2894	Sept. 27...	992
Oct. 15...	840	Oct. 30...	160	Nov. 10...	3568	Oct. 26...	5240
Nov. 14...	70	Nov. 28...	5	Dec. 10...	6	Nov. 25...	2327
Dec. 13...	...	Dec. 28...	...			Dec. 24...	...
Total	4854	Total	4963	Total	14169	Total	14260
1880.				1883.			
Jan. 11...	...	Jan. 27...	...	Jan. 9...	...	Jan. 23...	...
Feb. 10...	...	Feb. 26...	...	Feb. 7...	...	Feb. 22...	...
Mar. 11...	...	Mar. 26...	...	Mar. 9...	...	Mar. 23...	...
Apr. 9...	...	Apr. 24...	...	Apr. 7...	...	Apr. 22...	...
May 9...	...	May 24...	...	May 6...	...	May 22...	...
June 7...	190	June 22...	342	June 5...	6	June 20...	1435
July 7...	2650	July 21...	1611	July 4...	1594	July 20...	1977
Aug. 6...	1540	Aug. 20...	618	Aug. 3...	2427	Aug. 1...	1384
Sept. 4...	520	Sept. 28...	487	Sept. 1...	1692	Sept. 16...	1506
Oct. 4...	440	Oct. 28...	220	Oct. 1...	3647	Oct. 16...	8
Nov. 2...	890	Nov. 26...	510	Oct. 30...	1158		
Dec. 2...	650	Dec. 26...	...	Nov. 29...	333	Nov. 14...	165
				Dec. 29...	...	Dec. 14...	...
Total	6880	Total	3788	Total	10857	Total	6475

\* The catch for the whole week in which the new or full moon appeared is given in each case.

TABLE XXIV., Showing the Relation of the Phase of the Moon to the Catch of Herrings in Loch Fyne, 1860-1900—continued.

New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.	New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.
1884.				1887.			
Jan. 28...	...	Jan. 12...	...	Jan. 24...	...	Jan. 9...	...
Feb. 26...	...	Feb. 11...	...	Feb. 22...	...	Feb. 8...	...
Mar. 27...	...	Mar. 11...	...	Mar. 24...	...	Mar. 9...	...
Apr. 25...	...	Apr. 10...	...	Apr. 23...	...	Apr. 8...	...
May 24...	...	May 10...	...	May 22...	383	May 7...	525
June 23...	1284	June 8...	480	June 21...	575	June 5...	940
July 22...	1186	July 8...	990	July 20...	1769	July 5...	268
Aug. 20...	1546	Aug. 6...	1288	Aug. 19...	392	Aug. 3...	1289
Sept. 19...	792	Sept. 5...	248	Sept. 17...	716	Sept. 2...	413
Oct. 19...	14	Oct. 4...	63	Oct. 16...	184	Oct. 2...	20
Nov. 17...	...	Nov. 3...	...	Nov. 15...	...	Oct. 31...	168
Dec. 17...	...	Dec. 2...	...	Dec. 14...	...	Nov. 30...	22
						Dec. 30...	...
Total	4822	Total	3069	Total	4019	Total	3645
1885.				1888.			
Jan. 16...	...	Jan. 1...	...	Jan. 13...	...	Jan. 28...	...
Feb. 15...	...	Mar. 1...	...	Feb. 11...	...	Feb. 27...	...
Mar. 16...	...	Mar. 30...	...	Mar. 12...	...	Mar. 27...	...
Apr. 15...	...	Apr. 29...	...	Apr. 11...	...	Apr. 26...	...
May 14...	...	May 28...	...	May 11...	...	May 25...	...
June 12...	1744	June 27...	2112	June 9...	18	June 23...	184
July 12...	1745	July 27...	959	July 9...	1518	July 23...	1738
Aug. 10...	905	Aug. 25...	1361	Aug. 7...	2608½	Aug. 21...	1073
Sep. 8...	1643	Sep. 24...	...	Sep. 6...	592½	Sep. 20...	64
Oct. 8...	3050	Oct. 23...	9	Oct. 5...	360½	Oct. 19...	267
Nov. 6...	...	Nov. 22...	...	Nov. 4...	...	Nov. 18...	...
Dec. 6...	...	Dec. 21...	...	Dec. 3...	...	Dec. 18...	...
Total	9087	Total	4441	Total	5097½	Total	3326
1886.				1889.			
Jan. 5...	...	Jan. 20...	...	Jan. 1...	...	Jan. 17...	...
Feb. 4...	...	Feb. 18...	...	Feb. 15...	...	Feb. 15...	...
Mar. 5...	...	Mar. 20...	...	Mar. 1...	...	Mar. 17...	...
Apr. 4...	...	Apr. 18...	...	Mar. 31...	...	Mar. 17...	...
May 4...	...	May 18...	...	Apr. 30...	...	Apr. 15...	...
June 2...	581	June 16...	451	May 29...	...	May 15...	...
July 1...	1502	July 16...	912	June 28...	449	June 13...	356½
July 31...	596	Aug. 14...	1251	July 28...	1397½	July 12...	1862½
Aug. 29...	1082	Sep. 13...	552	Aug. 26...	1655	Aug. 11...	676½
Sep. 27...	120	Oct. 13...	63	Sep. 25...	1825	Sep. 9...	207½
Oct. 27...	43	Nov. 11...	46	Oct. 24...	1671	Oct. 9...	1060
Nov. 25...	95	Dec. 11...	...	Nov. 23...	493	Nov. 7...	485
Dec. 25...	...			Dec. 22...	...	Dec. 7...	...
Total	4019	Total	3275	Total	7490½	Total	4648

\* The catch for the whole week in which the new or full moon appeared is given in each case

TABLE XXIV., Showing the Relation of the Phase of the Moon to the Catch of Herrings in Loch Fyne, 1860-1900—continued.

New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.	New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.
1890.				1893.			
Jan. 20...	...	Jan. 6...	...	Jan. 18...	...	Jan. 2...	...
Feb. 19...	...	Feb. 5...	...	Feb. 16...	...	Feb. 1...	...
Mar. 20...	...	Mar. 6...	...	Mar. 18...	...	Mar. 2...	...
Apr. 19...	...	Apr. 5...	...	Apr. 16...	...	Apr. 1...	...
May 18...	...	May 4...	...	May 15...	...	May 30...	...
June 17...	258	June 3...	160	June 14...	464	June 29...	1237
July 17...	3006	July 2...	2213	July 13...	3577½	July 28...	3320
Aug. 15...	3373½	Aug. 30...	800½	Aug. 11...	2866½	Aug. 27...	1559½
Sep. 14...	1161½	Sep. 28...	...	Sep. 10...	686½	Sep. 25...	364
Oct. 13...	698	Oct. 27...	303	Oct. 9...	17	Oct. 25...	436
Nov. 12...	184	Nov. 26...	1417	Nov. 8...	800	Nov. 23...	345
Dec. 12...	1336	Dec. 26...	954	Dec. 8...	412	Dec. 23...	1000
Total	10017	Total	5847½	Total	8823½	Total	8261½
1891.				1894.			
Jan. 10...	...	Jan. 25...	...	Jan. 7...	...	Jan. 21...	...
Feb. 9...	...	Feb. 23...	...	Feb. 5...	...	Feb. 20...	...
Mar. 10...	...	Mar. 25...	...	Mar. 7...	...	Mar. 21...	...
Apr. 8...	...	Apr. 24...	...	Apr. 6...	...	Apr. 20...	...
May 8...	...	May 23...	...	May 5...	...	May 19...	...
June 6...	779	June 22...	358	June 3...	66	June 18...	1125
July 6...	1562	July 21...	1965	July 3...	2946	July 17...	1428
Aug. 4...	1069½	Aug. 19...	996	Aug. 1...	4136	Aug. 16...	759½
Sep. 3...	426½	Sep. 18...	988½	Aug. 30...	1089	Sep. 15...	607
Oct. 3...	792	Oct. 17...	1016	Sep. 29...	1125	Oct. 14...	424
Nov. 1...	5001	Nov. 16...	1593	Oct. 28...	20	Nov. 13...	510
Dec. 1...	958	Dec. 15...	1015	Nov. 27...	2357	Dec. 12...	2229
Dec. 31...	2253			Dec. 27...	1573		
Total	12840½	Total	7931½	Total	13312	Total	7082½
1892.				1895.			
Jan. 29...	...	Jan. 14...	...	Jan. 25...	...	Jan. 11...	...
Feb. 28...	...	Feb. 12...	...	Feb. 24...	...	Feb. 9...	...
Mar. 28...	...	Mar. 13...	...	Mar. 26...	...	Mar. 11...	...
Apr. 26...	...	Apr. 12...	...	Apr. 25...	...	Apr. 9...	...
May 26...	...	May 11...	...	May 24...	...	May 8...	...
June 24...	1118	June 12...	709	June 22...	448	June 7...	263
July 23...	4055½	July 10...	1096	July 22...	1029	July 6...	1458
Aug. 22...	2503	Aug. 8...	1805	Aug. 20...	359½	Aug. 5...	1249½
Sep. 21...	2038	Sep. 6...	2296½	Sep. 18...	134	Sep. 4...	955
Oct. 20...	1014	Oct. 6...	1449	Oct. 18...	49	Oct. 3...	27
Nov. 19...	211	Nov. 4...	679	Nov. 16...	177	Nov. 2...	18½
Dec. 19...	2000	Dec. 4...	1000	Dec. 16...	213	Dec. 2...	257
Total	12939½	Total	9034½	Total	2409½	Total	4198

\* The catch for the whole week in which the new or full moon appeared is given in each case.

TABLE XXIV., Showing the Relation of the Phase of the Moon to the Catch of Herrings in Loch Fyne, 1860-1900—continued.

New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.	New Moon.	*Catch in Crans.	Full Moon.	*Catch in Crans.
1896.				1898 (cont'd).			
Jan. 14...	...	Jan. 30...	...	Aug. 17...	2001	Aug. 2...	1880
Feb. 13...	...	Feb. 28...	...	Sept. 16...	1697	Sept. 29...	539
Mar. 14...	...	Mar. 29...	...	Oct. 15...	1212	Oct. 29...	481
Apr. 13...	...	Apr. 27...	...	Nov. 14...	510	Nov. 28...	1383
May 12...	...	May 26...	...	Dec. 13...	...	Dec. 27...	...
June 11...	236	June 25...	668	Total	10351	Total	6425
July 10...	905	July 24...	753				
Aug. 9...	491	Aug. 23...	429	1899.			
Sep. 7...	684	Sep. 21...	246	Jan. 11...	...	Jan. 26...	...
Oct. 6...	654	Oct. 21...	55	Feb. 10...	...	Feb. 25...	...
Nov. 5...	1515	Nov. 20...	427	Mar. 11...	...	Mar. 27...	...
Dec. 4...	128	Dec. 20...	...	Apr. 10...	...	Apr. 25...	...
Total	4613	Total	2578	May 9...	...	May 25...	...
1897.				June 8...	678	June 23...	1386
Jan. 3...	...	Jan. 18...	...	July 7...	1832	July 22...	2666
Feb. 1...	...	Feb. 17...	...	Aug. 6...	3320	Aug. 21...	934
Mar. 3...	...	Mar. 18...	...	Sept. 5...	579	Sept. 19...	329
Apr. 2...	...	Apr. 17...	...	Oct. 4...	740	Oct. 18...	360
May 1...	...	May 16...	...	Nov. 3...	1079	Nov. 17...	437
May 31...	...			Dec. 3...	644	Dec. 17...	134
June 30...	719	June 14...	154	Total	8872	Total	6246
July 29...	2222	July 14...	1307				
Aug. 28...	2216	Aug. 12...	3204	1900.			
Sept. 26...	2302	Sept. 11...	5831	Jan. 2...	...	Jan. 16...	...
Oct. 25...	2121	Oct. 10...	320	Jan. 31...	...	Feb. 14...	...
Nov. 24...	2949	Nov. 9...	886	Mar. 1...	...	Mar. 16...	...
Dec. 23...	1320	Dec. 9...	70	Mar. 30...	...	Apr. 15...	...
Total	13849	Total	11772	Apr. 29...	...	May 14...	...
1898.				May 28...	124	May 13...	...
Jan. 22...	...	Jan. 8...	...	June 27...	1635	June 13...	417
Feb. 20...	...	Feb. 6...	...	July 26...	1194	July 12...	1457
Mar. 22...	...	Mar. 8...	...	Aug. 25...	2480	Aug. 10...	357
Apr. 20...	...	Apr. 6...	...	Sept. 23...	1129	Sept. 9...	511
May 20...	...	May 6...	...	Oct. 23...	97	Oct. 8...	232
June 19...	971	June 4...	95	Nov. 22...	525	Nov. 6...	24
July 18...	3960	July 3...	2047	Dec. 22...	33	Dec. 6...	1399
				Total	7187	Total	4397

\* The catch for the whole week in which the new or full moon appeared is given in each case.

## II.—THE FOOD VALUE OF THE HERRING.

By T. H. MILROY, M.D., B.Sc., F.R.S.E., Professor of Physiology,  
Queen's College, Belfast.

## PART II.

## THE HERRING OF THE EAST COAST OF SCOTLAND.

In my previous paper, published in last year's Report, I dealt with the food value of the herring in the Loch Fyne and neighbouring areas, and, at the desire of the Fishery Board, I have carried out a similar investigation dealing with the fish of the East Coast. The general plan of investigation was the same in the later investigation. In only one important respect did it differ, namely, in the addition of one analysis, that of the coagulable proteids of the muscle of herring.

It is therefore only necessary to describe this method of analysis, and the reader is referred to the earlier paper for a description of the other methods.

Under the heading "Proteid" in the analytical tables of the earlier paper the amounts were given as calculated from the total nitrogen of the muscle, multiplied by the "proteid" factor, 6.25.

In this investigation it was thought advisable to estimate the coagulable proteid.

The method of estimation was as follows :—

Five grammes of minced fresh muscle were taken and placed in a mortar and 5 grammes of absolutely anhydrous sodium sulphate were added. The salt and the muscle were thoroughly mixed together so that the water of the latter might be taken up by the former anhydrous salt. About 100cc. methylated spirit were then added, and the mixture placed in a flask with a reflux condenser fitted to it. The mixture was then boiled for about three-quarters of an hour to ensure complete coagulation of the muscle proteids. The alcohol was then decanted off and the residue extracted with fresh quantities of boiling distilled water until the washings were free from sulphate. The coagulated muscle proteid, which was then left, was incinerated with sulphuric acid, cupric and potassium sulphate, and the nitrogen estimated in the usual way by Kjeldahl's method. On multiplying the amount of nitrogen by 6.25 the amount of "coagulable" proteid was obtained.

The results of the analyses are given in the following tables, which deal with the several batches of herrings sent to me by the Fishery Board.

In conclusion, I have given a table collecting the results of the analyses of the muscle of the female fish at various stages of reproductive activity. It was not necessary in this investigation to analyse the ovarian substance, as that was done sufficiently thoroughly in the earlier paper.

Under the heading "Per average fish" the amounts of the various nutritive principles in the average fish of the series are given after deduction of one-third of the weight to cover the amount of bones, skin, &c.

FRASERBURGH, JULY 7, 1906.

These herrings were caught 30 miles N.N.E. from Kinnaird Head, and were of the class known as "Fulls." In the catch, however, which would be about 25 crans, the bulk consisted of much smaller immature fish.

*Length.	Girth.	Weight.	Ovaries.	Diameter of Ova.
Cm.	Cm.	Gm.	Gm.	Mm.
25	14½	163	16·66	·6-·8
26	15½	204	30·50	·9
26	14½	190	33·02	·9
26	13½	161	20·35	·6-·7
26	14	175	17·19	·6-·7
Avg. 26	14	178·6	23·54	

\*The measurements (length and girth) are given in centimetres, and the weights in grammes. The diameter of the ova is given in millimetres.

The muscle of the male fish was also analysed, but the results of the analyses were practically identical with the female muscle, and so will not be given.

*Fresh Muscle of Females :—*

## (a) Percentages.

Water.	Total Proteid.	Coagulable Proteid.	Fat.
65·24	19·21	16·50	12·44

## (b) Per average fish (muscles).

Total Proteid.	Coagulable Proteid.	Fat.
22·85	19·63	14·80

BRESSAY, SHETLAND, JULY 10, 1906.

These herrings were sent by the fishery officer, labelled "Fulls," but, as will be seen from the table, they were by no means fully developed.

Length.	Girth.	Weight.	Weight of Ovaries.	Diameter of Ova.
26½	13½	170	6·75	·45
28	13½	178	5·20	·45
26	13	155	3·61	·45
28	13½	184	5·15	·45
27	13½	156	15·31	·50
29	14	198	20·80	·4-·5
27	13	176	5·35	·35-·4
Avg. 27·3	13·4	174	8·88	

(a) Percentages.

Water.	Total Proteid.	Coagulable Proteid.	Fat.
60·83	19·21	16·26	14·68

(b) Per average fish (muscles).

Total Proteid.	Coagulable Proteid.	Fat.
22·28	18·86	17·02

As the muscles of the male fish were richer in fat than those of the females, the analyses are also given.

*Males (Bressay Herring)—Measurements.*

Length.	Girth.	Weight.	Weight of Testes.
26	13	142	23·0
28	14	205	17·2
26	14	181	22·5
27	13	147	5·1
25	14	142	21·7
26	14	184	19·1
Avg. 26·3	13·6	167	18·1

(a) Percentages.

Water.	Total Proteid.	Coagulable Proteid.	Fat.
57·55	20·60	13·54	17·14

(b) Per average fish.

Total Proteid.	Coagulable Proteid.	Fat.
22·94	15·08	19·09

LERWICK, AUGUST 9, 1906.

Three batches of herrings were sent on August 9, by Mr. R. Duthie, classed respectively as "Fulls," "Matties," and "Spents." As there were, however, differences in those sent as "Matties," these were subdivided into two sets.

*A.—Eight Large Full Herrings—Five Females.*

*Females.*

Length.	Girth.	Weight.	Weight of Genitals.	Diameter of Ova.
31	15·5	245	60·4	·9
30	15·5	241	51·8	1·0
30	14	212	33·8	·9
31	15	247	56·5	·9
32	16	282	51·8	·8
Avg. 30·8	15·2	245·4	50·8	·9

*Males.*

Length.	Girth.	Weight.	Weight of Genitals.
30	15	234	51·9
30	15	202	35·4
30	16	267	55·9
Avg. 30	15·3	234	47·7

*A. Muscle (Females).**(a) Percentages.*

Water.	Total Proteid.	Coag. Proteid.	Fat.
65·25	21·26	16·37	7·53

*(b) Per average fish.*

Total Proteid.	Coag. Proteid.	Fat.
34·78	26·78	12·31

*A. Muscle (Males).**(a) Percentages.*

Water.	Total Proteid.	Coag. Proteid.	Fat.
64·20	21·67	18·28	9·72

*(b) Per average fish.*

Total Proteid.	Coag. Proteid.	Fat.
33·80	28·51	15·16

*B.—“Malties” sent from Lerwick, August 9, 1906.*

As some of the herring sent were spent and others contained moderately large ovaries with fairly well developed ova, they were divided into two sets—B. and BA.

*B.*

Length.	Girth.	Weight.	Weight of Ovaries.	Diameter Ova.
24·5	13	134	15·5	·7
25·5	13	140	15·5	·7
25	13	137	15·5	·7

*(a) Percentages.*

Water.	Total Proteid.	Coag. Proteid.	Fat.
57·27	21·10	16·90	16·68



(b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
19·28	15·44	15·24

BA.—*Lerwick* (August 9, 1906).

Length.	Girth.	Weight.	Weight of Ovaries.	Diameter of Ova.
27	11	130	2·2	Spent.
26	12	132	0·2	"
26	12	120	1·4	"
26	13	138	1·4	"
Avg. 26·25	12	130	1·3	...

There were large numbers of very immature ova within the capsules of the spent ovaries.

(a) Percentages.

Water.	Total Proteid.	Coag. Proteid.	Fat.
63·24	21·67	...	10·42

(b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
18·78	...	9·03

C.—*Spent Herrings* (*Lerwick*), August 9, 1906.

*Females.*

Length.	Girth.	Weight.	Weight of Ovaries.	Ova.
29	13	163	2·1	Spent, but with large numbers of very small ova, ·05–1mm.
30	14	180	2·7	
29	13	147	1·3	
28	13	150	2·0	
28	14	158	2·0	
Avg. 28·8	13·4	159·6	2·02	

(a) Percentages.

Water.	Total Proteid.	Coag. Proteid.	Fat.
67·29	19·02	16·00	8·19

(b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
20·23	17·02	8·71

## C.—Males.

Length.	Girth.	Weight.	Weight of Testes.
28	13	138	1·4
31	14	214	2·8
29	14	178	2·9
28	13	130	1·8
29	13	165	1·9
Avg. 29	13·4	174	2·16

## (a) Percentages.

Water.	Total Proteid.	Coag. Proteid.	Fat.
66·65	22·23	17·20	6·57

## (b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
25·78	19·95	7·62

## KINNAIRD HEAD, AUGUST 9, 1906.

Four batches of herrings were sent on August 9, 1906. They were caught 18 miles north-east from Kinnaird Head, and were labelled by the fishery officer as—No. I., "Large Fulls"; No. II., "Spents"; No. III., "Matt. Fulls"; No. IV., "Matties." I shall give the analyses of each set in the above order.

## No. I.—"Large Fulls."

## Females.

Length.	Girth.	Weight.	Weight of Ovaries.	Diameter of Ova.
29	16	230	49	1mm.
29	15	215	41	·8-·9
30	15	228	51	·8-·9
29	17	231	51	·9
29	14	223	43	·8-·9
29	14	213	45	·9
Avg. 29·1	15·1	223·3	46·6	

## (a) Percentages.

Water.	Total Proteid.	Coag. Proteid.	Fat.
64·84	20·28	13·28	9·06

## (b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
30·19	19·77	13·49

No. I.—*Males.*

Length	Girth.	Weight.	Weight of Testes.
29	15	219	42
29	15	213	44
29	15	215	42
29	14	198	40
29	17	240	50
30	15	237	43
Avg. 29	15.1	220.3	43.5

(a) Percentages.

Water.	Total Proteid.	Coag. Proteid.	Fat.
63.72	20.39	17.28	8.43

(b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
29.95	25.38	12.38

No. II.—“*Spents,*” August 9, 1906.

Length.	Girth.	Weight.	Weight of Ovaries.	Ova.
30	12	135	1.65	Spent ovaries, but large numbers of developing ova present.
30	13	159	2.00	
28	13	157	2.07	
29	12	150	1.97	
28	11	148	2.44	
Avg. 29	12.2	149.8	2.02	

(a) Percentages.

Water.	Total Proteid.	Coag. Proteid..	Fat.
65.09	19.90	12.66	6.14

(b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
19.18	12.64	6.14

No. III.—“*Matt. Fulls,*” August 9, 1906.

Length.	Girth.	Weight.	Weight of Ovaries.	Diameter of Ova.
26	13½	167	26.7	.9
25	13½	153	17.7	.9
25	13	152	26.8	.9
25	13½	148	28.5	.9-1
25	13	134	15.5	.9
Avg. 25.2	13.3	150.8	23.04	

## (a) Percentages.

Water.	Total Proteid.	Coag. Proteid.	Fat.
57.29	23.81	17.31	15.13

## (b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
23.81	17.31	15.13

No. IV.—“Matties,” August 9, 1906.

Length.	Girth.	Weight.	Weight of Ovaries.	Diameter of Ova.
23.5	11	99	8.4	.5-.7
23.5	11.5	112	3.6	.4-.5
23.5	10.5	102	6.8	.5
24	12	114	1.8	.4
24	12	124	0.6	.08-.1
24.5	11	111	1.0	.08-.1
23	10.5	100	3.0	.4
Avg. 23.7	11.2	108	3.6	

## (a) Percentages.

Water.	Total Proteid.	Coag. Proteid.	Fat.
55.72	21.16	16.92	15.50

## (b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
15.23	12.18	11.16

LERWICK, SEPTEMBER 1, 1906.

Two boxes of herrings were sent from Lerwick, one set being mature and the other spent.

As a very large number were measured and weighed, it will be sufficient in each case simply to give the average measurements and weights.

## I.—Large Mature Herring.

	Length.	Girth.	Weight.	Weight of Ovaries.	Diameter of Ova.
Avg.	29.5	15	240	50	1.2

The herring were just about to spawn.

## (a) Percentages.

Water.	Total Proteid.	Coag. Proteid.	Fat.
60.23	20.72	16.92	12.44

## (b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
33.15	27.07	19.90

II.—Spent Herring (Lerwick), September 1, 1906.

Length.	Girth.	Weight.	Weight of Ovaries.
Avg. 29	13	171	These consisted only of collapsed membranes containing large numbers of very small ova.

(a) Percentages.

Water.	Total Proteid.	Coag. Proteid.	Fat.
63·51	22·55	17·20	9·32

(b) Per average fish.

Total Proteid.	Coag. Proteid.	Fat.
25·70	19·60	10·62

In order to be able readily to compare the composition of the muscular tissue of the East Coast herrings in different stages of reproductive activity, it is advisable to give a table which gives the collective results.

Date.	Place.	AVERAGES.					PERCENTAGES.			
		Length.	Girth.	Weight.	Weight of Ovaries.	Diam. of Ova.	Water.	Total Proteid.	Coag'ble Proteid.	Fat
July 7th, 1906, ..	Fraserburgh, .. ..	26	14·4	178·6	23·54	6-9	65·24	19·21	16·5	12·44
July 10th, 1906, ..	Bressay, .. ..	27·3	13·4	174	8·88	3-5	60·83	19·21	16·2	14·68
Aug. 9th, 1906, ..	Lerwick—									
	A. "Fulls," .. ..	30·8	15·2	245·4	50·8	9-1	65·25	21·28	16·37	7·53
	B. "Matties," .. ..	25	13	137	15·5	7	57·27	21·16	16·90	16·68
	BA. "Matties," .. ..	26	12	130	1·3	Spent, but with small ova.	63·24	21·67	..	10·42
	C. "Spents," .. ..	28·8	13·4	159·6	2·02	Spent.	67·29	19·82	16·00	8·19
	Kinnaird Head—									
Aug. 9th, 1906, ..	I. "Fulls," .. ..	29·1	15·1	223·3	46·6	8-1	64·84	20·28	13·28	9·06
	II. "Spents," .. ..	29	12·2	149·8	2·02	Spent.	65·09	19·90	12·66	6·15
	III. "Matt. Fulls," ..	25·2	13·3	150·8	23·04	9-1	57·29	23·81	17·31	15·13
	IV. "Matties," .. ..	23·7	11·2	108	3·6	1-7	55·72	21·16	16·92	15·50
Sept. 1st, 1906, ..	Lerwick—									
	I. "Fulls," .. ..	29·5	15	240	50	1-2	60·23	20·72	16·92	12·44
	II. "Spents," .. ..	29	13	171	Spent	Spent	63·51	22·55	17·20	9·32

One may shortly summarise the results of these analyses of autumn East Coast herrings as follows. The analyses in the table refer solely to the flesh (muscles) of female herrings.

(1) Referring, in the first place, to the herrings obtained in August and September, the water percentage is highest in large spent fish, and following closely upon this comes the large full fish.

Spent "Matties" (Ba.) have a slightly lower water percentage than the large full herrings. The unspent "Matties" (B.) and the "Matt. Fulls" (No. III., August 9th) contain practically the same amount of water. The lowest percentage of water was present in the "Matties" of August 9th.

The only point of importance in connection with the water in the muscles of the July herring is that, with the increase in development of the ovaries, there is an increase in the water content of the muscles.

One may therefore state shortly that the water percentage of the muscles rises as the ovaries become more mature, and the maximum is reached when the fish are spent.

(2) *The Total Proteid Percentage.*—There are but slight variations in this. It was highest in the "Matt. Fulls" of August 9th and lowest in the "Spents" (C.) of August 9th. As however may be seen from the table, the proteid percentage in spent fish may be very high.

(3) *Coagulable Proteid.*—This is more important as an indication of the nutritive value, as it represents the proteids which are coagulated on boiling the fish.

Referring to the Lerwick and Kinnaird Head herrings (August 9th), which are more easily compared, the highest percentage is present in the "Matt. Fulls" and "Matties" and the lowest in the "Spents" and "Fulls." The September Lerwick herring—"Fulls" and "Spents"—contained, however, a high percentage of coagulable proteid.

(4) *Fats.*—The percentage amount of fat in the fish is probably regarded by most people as the best standard for estimating its nutritive value. It is in many respects the most valuable indication of the value of the herring; but, as pointed out in my previous paper, it must not be regarded as the sole one.

There can be no doubt about the results of the analyses. The herrings richest in fat are the "Matties" and "Matt. Fulls," the poorest the "Large Spents" and "Large Fulls." The lowest fat percentage was present in the "Large Spents" obtained from Kinnaird Head on August 9th.

Taken as a whole, the spent fish have a lower fat percentage than the corresponding full fish, but it is possible that in some cases the fat percentage of even spent fish may be higher than that of "Fulls." One may easily understand how this may occur, as the fish may have commenced to store fat again. For example, the spent fish obtained from Lerwick on August 9th were evidently, so far as the fat percentage was concerned, in slightly better condition than the Lerwick mature fish and also than the Kinnaird Head spent fish.

In conclusion, on comparing these East Coast herrings with the West Coast fish (see previous paper), one is mainly struck by the lower water and higher proteid and fat percentages in the former than the latter.

I never obtained such low fat percentages in the East Coast fish as were obtained in some of the winter West Coast herrings. There are many other points of interest in the tables, but these can be readily appreciated by a study of the various analyses. I have not grouped together the results of the analyses of the male fish, as this was scarcely necessary.

From a study of the tables given in this paper, and the preceding series of analyses (West Coast herrings), one is struck by the fact that the fish which possess, as a rule, the highest percentage of fat in their muscles are those whose ovaries are still some time short of full maturity. Usually fish with ovaries of 15-20 grammes weight (weight at full maturity about

60 grammes) contain the highest percentage of fat in their muscles. From a careful examination of all the tables, one is led, however, to believe that practically until full maturation of the ovaries, there is an increase in the weight of the fish, while after spawning the loss of weight is greater than can be accounted for from the discharge of the ova.

It is quite probable that the decrease in fat of the muscles is accompanied by an increase in water. It is unfortunate that, especially in the case of the herring muscle, it is difficult to obtain reliable figures for the water percentage. There can be no doubt, however, that there is an increase in the water percentage of the muscles in spent fish. As regards the fat, there can be no doubt that there is a gradual loss of this important food material during the later stages of maturation, succeeded by a serious loss after the spawning of the fish. This loss after spawning is evidently a very rapid one as, although there must be a short period after spawning when the spent fish contains practically the same amount of fat as the full fish, it is rare that one observes this in analyses, and when one does so it is possibly in some cases due to the fact that one is examining a spent fish that is in the period of recuperation.

When one remembers that the fat is the stored material which will be used up before the proteids of the muscles after the food intake becomes insufficient to cover the body requirements, one is led to suppose that, for some time before full maturation of the ova, the fish either ceases to feed or, what is more likely, takes an insufficient supply to prevent a loss of the body fat. The analyses which I have made support, therefore, in the main, Heincke's conclusions as to the various stages in the reproductive life of the herring (*Twenty-fourth Annual Report of the Fishery Board for Scotland*, Part III., p. 102). If my supposition be correct, then the fish is at its best, regarded as a source of nutritive material, at a period somewhat short of full maturity of the genitalia.

The herring is, however, very unlike the salmon in that there is certainly no prolonged period during which the fish refrains from food. There is only probably a short period in the reproductive life of the herring comparable to that in the case of the salmon, and that is the month, or probably two months, just preceding spawning, when the fish has not only to obtain the necessary energising material for work from its own tissues, but has also to supply the growing ovaries or testes from the same source. It is, however, after spawning that the muscles of the fish lose the largest amount of their stored nutritive material, and it is then that the most undoubted loss of weight occurs, over and above that which can be accounted for by the complete discharge of the ovaries.

There are two periods during which it would be most interesting to know the changes which the nitrogenous constituents of the muscles are undergoing, namely, in the first place, during the later stages of maturation and earlier period in the spent condition (a condition of starvation), and secondly, in a later stage after spawning when recuperation is taking place.

I am at present investigating this subject of the alterations in the chemical nature of the proteids of the herring's muscles during different periods of reproductive activity.

I would like to thank the various fishery officers for the care and trouble taken in the packing and preservation of the fish. Without their valuable assistance it would have been impossible to get the fish in proper condition for chemical investigation.

ERRATA\* REFERRING TO PAPER IN PART III. OF  
TWENTY-FOURTH ANNUAL REPORT.

(To be Corrected also in Tables on pp. 99 and 100, where the  
Analyses are collected together).

Page 91.—Series B.

Muscles—(b).

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
18.99	16.25	.73
instead of 14.80	12.51	.55

Ovaries—(b) .08 instead of .05 P<sub>2</sub>O<sub>5</sub>

Males—

Muscle—(b).

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
17.91	13.98	.55
instead of 18.44	14.39	.57

Testes—(b) .20 instead of .13 P<sub>2</sub>O<sub>5</sub>

Page 93.—Females—

Muscle—(b).

Proteid.	Fat.	P <sub>2</sub> O <sub>5</sub>
34.97	19.09	1.03
instead of 52.45	28.64	1.55

Page 94.—Ovaries (b).

Proteid.	Fat.
8.46	1.02
instead of 9.82	1.00

Page 98.—Ratio of total Proteid of Muscles to total Proteid of Ovaries.

Oct. B.—9.1 : 1, instead of 7.1 : 1.  
Nov. 6.—4.7 : 1, instead of 7.1 : 1.  
Dec. 6.—3.3 : 1, instead of 2.9 : 1.  
Dec. 13.—3.4 : 1, instead of 3.3 : 1.

Ratio of total Fat of Muscles to total Fat of Ovaries.

Oct. B.—36.9 : 1, instead of 28.4 : 1.  
Nov. 6.—22.7 : 1, instead of 34 : 1.  
Dec. 6.—3.3 : 1, instead of 3.48 : 1.

\* As will be readily seen on consultation of the tables in the earlier paper, these errata only refer to the quantities per average fish and not to the percentages.



III.—SOME ADDITIONAL NOTES ON COPEPODA FROM  
THE SCOTTISH SEAS.

By THOMAS SCOTT, LL.D., F.L.S., Mem. Soc. Zool. de France.

(Plates XIII.—XV.)

The descriptions of several of the new or rare Copepoda obtained during the investigations that have been carried out under the direction of the Fishery Board for Scotland, and published in the earlier Annual Reports of the Board, were for various reasons somewhat incomplete. In some cases only the female was available for description, the male being at the time unknown; while in others, where the species, though rare, was already established, only the fact of its occurrence in our seas was recorded and the description of it left to some future occasion.

In the remarks which follow I have, with the help of the drawings prepared for me by my son Andrew Scott, A.L.S., endeavoured to describe somewhat fully three curious forms obtained from different Scottish localities, where they have occurred in sufficient numbers to permit of a more accurate study of the peculiar characteristics by which they are distinguished than was possible at the time they were first recorded.

These species include the two Harpacticoida *Harrietella simulans*, T. Scott, and *Laophontodes typicus*, T. Scott, of which only the females have been previously recorded, together with a description of what appears to be the male and female of a remarkable species known as *Notopterophorus papilio*, Hesse, found as a commensal in the branchial chamber of large Ascidians.

Descriptions are also given of two Copepod parasites of fishes which do not appear to have been previously recorded, and which belong to a somewhat aberrant genus of the Caligoida, viz., *Nogagus*.

These different forms are described in the sequel in the order in which they are here referred to.

It may also be stated that the species mentioned above, though only now described, have been in my possession for several years, the publication of their description having been for various reasons delayed.

Division Harpacticoida, G. O. Sars.

Fam. Laophontidæ, G. O. Sars.

Genus *Harrietella*, T. Scott.

*Harrietella simulans*, T. Scott. Pl. xiii., figs. 1–5.

1894 (?) *Laophonte simulans*, T. Scott, Twelfth Annual Report of the Fishery Board for Scotland, Pt. III., p. 248. Pl. vii., figs. 24–32.

1906. *Harrietella simulans*, T. Scott., Ann. and Mag. Nat. Hist. Ser. 7, vol. xvii., p. 464, pl. xi., figs. 9 and 10.

The structure of *Harrietella simulans* is in some respects similar to that of *Laophonte*, Philippi, and, therefore, while differing considerably in one or two points, it was, when first discovered, ascribed, though

with some doubt, to this genus, especially as only the females had at that time been noticed. The discovery of additional specimens allowed a more thorough examination to be made of the structure of the species, and it then became evident that its place in *Laophonte* was untenable, and this rendered its removal to another genus—*Harrietella*—necessary.

But while the female of this species has been known for a number of years, the male has apparently remained undescribed. I, therefore, in the following additional notes on the species, include a short description of the male form.

The species is a very small one, the female being scarcely half a millimetre in length, but the male is still smaller. It is a demersal form, and, like a number of other such forms, its distribution is somewhat restricted. I have rarely noticed *H. simulans* among the numerous bottom forms occasionally captured with the dredge, even at some of the more favourable collecting grounds in the Firths of Forth and Clyde; yet when a piece of decaying wood, the surface of which is perforated by boring molluscs or crustaceans, is brought up in the dredge or trawl net, numerous examples of this particular Copepod may be obtained living apparently in the crevices of the wood. When the pieces of decaying wood are carefully removed from amongst the other debris and washed in a bottle containing methylated spirits, and the sediment examined under a hand lens, quite a number of little animals may sometimes be obtained.

In *Laophonte* the body is usually of a narrow, oblong form, but in *Harrietella* it is broadly ovate and considerably depressed; and while in *Laophonte* the female carries only one ovisac, there are two in *Harrietella*. In the structure of the mouth appendages—the mandibles, maxillæ, and maxillipeds—there is a fairly close resemblance between the two genera, and the same may be said concerning the two pairs of antennæ and the first pair of thoracic feet. The second and third pairs in both the male and female, and especially in the male, though in their general structure somewhat resembling those of *Laophonte*, they are distinctly more robust. In both pairs the inner branch is composed of two sub-equal joints, the first being rather shorter than the other. In the male, the inner branch of the second and third pairs, which does not reach the end of the second joint of the outer branch, is furnished with two apical setæ. The outer branch is elongated and stout, and composed of three joints of nearly equal length; the first and second are each provided with a single moderately-long spine on the outer margin, and the third joint, which is furnished with a similar spine on the outer edge, bears also three strong terminal spines (fig. 3 represents one of the second pair of feet). The fourth pair in the male resembles that of the female in having the inner branch short, narrow, and uni-articulated, and provided with two short apical setæ; but while the outer branch in the female is two-jointed, that of the male consists of three joints, the first two being each provided with a moderately long and stout plumose seta on the outer margin, and the third with four similar setæ round the distal extremity. The outer branch of the fourth pair in the male, like the same pair in the female, is remarkably stout (fig. 4).

The fifth pair in the male consists of an oblong basal joint, provided with a spiniform seta on the inner distal angle and a setiferous appendage on the outer, and a small one-jointed branch bearing a few plumose bristles (fig. 5).

In the male, the last two segments of the metasome, though nearly uniform in width with those of the urosome, are distinctly narrower than the preceding segments, and in this respect there is a marked difference between the two sexes when seen from above.

In the female the width of the posterior segments decreases gradually instead of abruptly.

The antennules of the male are modified to form powerful grasping organs, as shown in the drawing (fig. 2).

The distribution of this curious species appears to be local rather than rare, and since its discovery in the crevices of decaying fragments of wood, its occurrence in similar situations has occasionally been noticed both in the Firth of Forth and the Firth of Clyde, and it may probably be found in such situations round other parts of our shores.

Genus *Laophontodes*, T. Scott.

*Laophontodes typicus*, T. Scott. Pl. xiii., figs. 6-15.

1894. *Laophontodes typicus*, T. Scott, Twelfth Annual Report of the Fishery Board for Scotland, Pt. III., p. 249, Pl. viii., figs. 2-8.

It is thirteen years since a description of this species was first published in the Board's Twelfth Annual Report. The description was prepared from female specimens, the male being at that time unknown; and as, so far as I know, it has not yet been recorded, the following observations on its structure, with some additional remarks on the female, will render the former description more complete.

This species, like the last, is very small, the largest of our female specimens is scarcely .5 millimetre (about  $\frac{1}{20}$  of an inch) in length, while the males are only about one-sixtieth of an inch; they may therefore be easily overlooked.

In both the male and female the body is elongated and narrow, and is considerably depressed (fig. 6). The male, though smaller than the female, does not differ much from it in general appearance.

The anterior antennæ in the male are composed of the same number of articulations as those of the female, but the last three joints are considerably modified, as shown in the drawing (fig. 7). The third joint is small, the next is dilated and gibbous, while the last forms a slender hook-like process.

The mandibles are very small, and the biting-edge is armed with a few prominent teeth. The mandible-palp consists of a single small one-jointed branch bearing several setæ (fig. 8).

The maxillæ are similar to the same organs in typical species of *Laophonte*, and consist of a broad masticatory lobe provided with several elongated slender spines, and a small bilobed palp (fig. 9).

The first maxillipeds are small but moderately stout, and the basal joint, which is somewhat dilated, is provided with a small setiferous process on the inner margin, while the end joint terminates in an elongated and moderately strong claw (fig. 10). The second maxillipeds are as previously described.

The first pair of thoracic feet are in structure nearly as in *Laophonte*, the inner branch being short and three-jointed, while the outer, which is two-jointed, is stout and furnished with a strong terminal claw (fig. 11). The second pair, like the first, is somewhat similar in the two sexes; the outer branch is slender and elongated and composed of three sub-equal joints, while the inner is short and two-jointed; the first joint of the inner branch is extremely small, but the second, though very slender, is of moderate length and furnished with two slender apical setæ. The third pair in the female is similar in structure and armature to the second, but the inner branch of this pair in the male has two peculiar

and moderately stout terminal appendages, one of which forms a short hook-like process, while the other is straight and terminates in two slender setæ of unequal length (fig. 12).

The structure of the fourth pair appears to be similar in the two sexes; the outer branch is moderately slender and elongated, and composed of three sub-equal joints armed with long spiniform setæ on the outer margin; the inner branch is very short and two-jointed, the first joint being extremely small, while the second is slender and moderately elongated, and furnished with three small terminal setæ (fig. 13).

The fifth pair in the female consists of a small basal joint to which is articulated a narrow elongated plate about four times longer than broad, and provided with a number of setæ arranged as shown in the drawing (fig. 14). In the male the fifth pair is similar to those of the female, but smaller and less spiniferous (fig. 15).

The furcal joints in both the male and female are elongated and slender and set widely apart; they are each furnished with a long and stiff apical bristle and a few small hairs (see fig. 6).

I have obtained this species in the same situations with the *Harrietella* previously mentioned, but it seems to be a rarer form, and males especially appear to be very scarce.

*Notodelphyoida*, G. O. Sars.

Fam. *Doropygida*.

Genus *Notopterophorus*, Coats.

*Notopterophorus papilio*, Hesse. Pl. xiv., figs. 1-19.

1865. *Notopterophorus papilio*, Hesse. Observations sur des Crustacés rares ou nouveaux des côtes de France, *Ann. des Sci. Nat.*, 5th Sér. zool., vol. i., p. 338, pl. xi., figs. 1-13.

1878. *Notopterophorus papilio*, G. S. Brady. A Monograph of the Free and Semi-parasitic Copepoda of the British Islands (*The Ray Society*), vol. i., p. 142, pl. xxxi., figs. 3-12.

The Entomostracan to which M. Hesse has given the name mentioned above is one of the most remarkable among a strange group of species found living as "unbidden guests" within the branchial chamber and sometimes in the alimentary canal of various simple and compound Ascidians.

The distinguishing characteristic of *Notopterophorus* is, as the name implies, the peculiar wing-like appendages of the cephalo-thorax, which give to the creature its somewhat grotesque appearance. These appendages, which are situated on the dorsal aspect, appear to be six in number, and assume the form of very thin and almost transparent plates, each of which terminates in long, slender, whip-like filaments. The frontal plate, which is obscurely triangular, has a hood-like structure, and appears to be furnished with three filaments—one central and one at each of the lateral extremities; this plate seems to be an expansion of the first thoracic segment. The next four plates occur in pairs; the first pair spring from the second segment of the thorax, and the following pair from the third segment, and each single plate bears two whip-like filaments. The posterior plate, which is of one piece, moderately large and broadly triangular, and which springs from near the distal end of the last segment of the thorax, is apparently provided

with three slender processes; two of them are prolongations of the lateral angles, and the other of the intermediate angle by which the posterior edge of the plate is divided into two sub-equal portions. It has to be noted, however, that these dorsal expansions are so extremely delicate that, though many specimens have been examined, it was rare to find one with the appendages uninjured. The following is M. Hesse's description of the posterior dorsal plate:—"Enfin la sixième expansion membraneuse que est aussi triangulaire comme celle placée sur l'occiput, est fixée un peu au-dessus de la base de l'abdomen qu'il recouvre, et semble destiné à protéger les oeufs ou les embryons. Son bord inférieur présente deux découpures, terminées par trois lanières, dont l'une est au milieu et les deux autres à l'extrémité du bord inférieur."

The cephalo-thorax in the female is comparatively large, and consists of five segments; in adult specimens, however, the segments are not very clearly defined. The first four do not differ much in size, but that which forms the head or *cephalosome* is rather smaller than the others. The last segment is fully twice the length of the preceding one, and is composed of two coalescent segments—the fourth and fifth segments of the *metasome*. This double segment is destined, as in other members of the *Notodelphyoida*, to be a receptacle for the eggs and developing larvæ, and when packed with eggs or larvæ it becomes considerably enlarged, and is also more highly coloured than other parts of the animal. (See fig. 1.)

In the female the abdomen—*urosome*—is moderately elongated, slender, and cylindrical, and is composed of five segments, but the prefurcal segment is very small and of a peculiar structure, and seems to overlap the base of the short furcal joints. These joints, which are somewhat arcuate, are each armed with about four very short but strong curved spines (fig. 19).

Neither the male nor the young female appears to be furnished with the prominent dorsal appendages possessed by the female that has reached the ovigerous stage. Figure 3 represents a young female with an adult male adhering to its dorsal surface, in both of which the wing-like expansions are wanting. The female appears to have reached the stage when these expansions are beginning to be developed, but in the male no trace of them can be observed, though its structure shows it to be a mature example.

In the specimens under consideration the antennules (anterior antennæ) are in both sexes apparently nine-jointed. In those of the female the first two joints are of large size, but the remaining joints are considerably shorter and narrower, and the second and third from the end are smaller than any of the others. The male antennules are moderately stout and taper gradually towards the distal extremity; the first two joints are not so dilated as the first two in the female, but the remaining seven joints are rather larger. (See figs. 4 and 5.)

The antennæ (posterior antennæ) of the male, though considerably smaller than those of the female, are similarly armed with strong terminal claws, as shown in figs. 6 and 7.

The mandibles are well developed and possess a broad, biting edge, armed with several irregular teeth; the mandible-palp is moderately large and two-branched; the proximal branch appears to be uni-articulate, but the other is two-jointed; both branches bear plumose setæ (fig. 8).

The maxillæ (fig. 9) are also moderately developed and supplied with numerous plumose setæ.

The first maxillipeds have the basal part greatly enlarged and provided with a number of long plumose setæ on its inner margin; the

second joint bears a long stout and curved spine; the end joint is narrow, about twice longer than broad, and furnished with a few terminal setæ (fig. 10).

The second maxillipeds are moderately stout and elongated; they are also apparently three-jointed, and bear a number of plumose setæ, as shown in the drawing (fig. 11).

All the thoracic feet, both in the male and female, are short and moderately stout, and the general structure of the first three pairs is somewhat similar in the two sexes, though they differ somewhat in the armature and in one or two other minor details.

In the first pair the inner branches are composed of two and the outer of three joints; there is not much difference in the length of the two branches. The second joint of the inner branch is rather longer than the first, while the middle joint of the outer branch is much smaller than either the first or the third joints. Both branches are similarly armed in the two sexes. The outer are furnished with several stout spines on the exterior margin and apex, and with a short plumose setæ on the inner margin. The inner branches are provided with a number of plumose setæ, especially on the inner edge, but those on the inner branches of the female are more elongated. There is also a stout sigmoid spine on the inner aspect of the second basal joint in the female first pair, which appears to be wanting in that of the male. (See figs. 12 and 13.)

The second pair in both sexes have the inner and outer branches three-jointed. In that of the female the inner branch is rather shorter than the outer; the first joint bears one setæ, the second two, and the third two on the inner margin; the third joint has also three apical setæ and another on the middle of the outer margin. All these setæ are elongated and plumose. The outer branch has the proximal joint moderately stout and as long as the next two joints taken together: it bears a single seta on the inner edge and a short spine on the outer distal angle; the second joint, which is smaller than the first or third, also bears a short marginal spine, while the third joint has two spines on the outer margin and two at the apex.

In the male the length of the outer and inner branches of the second pair is about the same; the armature of the inner margin of the inner branch is similar to that of the second pair in the female, but the end joint bears two terminal spines instead of setæ, with another spine on its outer margin; the armature of the outer branch in the male does not differ much from that of the same branch in the female, except that the marginal spines are rather longer. (See figs. 14 and 15.)

The third pair, as in the second just described, have in the two sexes both branches three-jointed. In the male the third pair scarcely differs from the second either in structure or armature. In the female the third pair is rather smaller than the second, but the inner branch carries the same number of plumose setæ, while the outer branch, though armed with the same number of marginal spines as that of the second, wants the seta on the inner margin of the first joint (fig. 16).

The fourth pair in the female is almost the same in structure and armature as the third pair; but in the male the fourth pair is very small, and though the outer branch consists of three joints, the inner is only two-jointed and distinctly shorter than the outer; both branches are provided with moderately stout spines (fig. 17).

The fifth pair consists of a narrow, elongated, one-jointed branch, which is articulated to a rudimentary basal joint and furnished with two slender apical spines (fig. 18). The female represented by the drawing (fig. 1) is about 4.5 millimetres in length.

*Remarks.*—The *Notopterophorus* described in the preceding notes, though it does not conform altogether to Hesse's description of *Notopterophorus papilio*, agrees with it in several important particulars, and I am therefore inclined to ascribe it to that species. Moreover, the mouth appendages described and figured here are apparently identical with those of the form recognised as belonging to Hesse's species in Dr. Brady's "Monograph of the Free and Semi-parasitic Copepoda of the British Islands," vol. 1., p. 142, plate xxxi., figs. 3–12.

The two habitus figures given in M. Hesse's original work and reproduced in the Monograph referred to are, in respect of the slender form of the cephalo-thorax, unlike any of the specimens I have examined. On the other hand, Hesse's description of the cephalo-thorax and abdomen agrees tolerably well with Scottish specimens of the adult female.\*

Another point of interest which is noticed by Dr. Brady is the great similarity between this species and the members of another genus, and in referring to this he says that "except for the peculiar wing-like dorsal appendages there seems to be little to separate this genus from *Doropygus*," and this corresponds with the opinions of other observers, and is also supported by the *Doropygus*-like form of the young female, and still more by the general character of the male. Still, the presence in the adult female of these remarkable appendages is in itself, I think, a sufficient reason for separating this and similar forms under the distinctive name established by Costa and utilised by M. Hesse.

The purpose which these curious and wing-like expansions serve in the life-history of the creature may be, as M. Hesse suggests, to assist its movements "or to aid in removing obstacles from its path." I am inclined, however, to agree with Dr. Brady, who says—"For my own part I find it difficult to believe that these excessively delicate organs can be of much use for such purposes, or to understand why, if they are so used, they should be entirely wanting in so many other species which live under the same conditions. We must, I think, admit that their use is at present quite unknown."†

I have obtained this Copepod in large Ascidians from various Scottish localities, but nowhere so common as in Ascidians dredged in Scapa Flow, Orkney. The branchial chamber of the large Ascidians dredged there was sometimes crowded with these Copepods.

Though many specimens have been examined by me from Scottish waters, they were apparently all of the one species, but examples were obtained in different stages of development, from the young females without dorsal appendages, or with a mere indication of them, to those that were adult and whose dorsum was ornamented with the appendages fully expanded.

In full-grown specimens the ovigerous sac was usually so distended, and the integument so thin and transparent, that through it the eggs or larvæ could be seen crowded together. Occasionally examples were observed with the ovigerous sac empty and collapsed, its contents having been set free.

Herr R. Buchholz has described what appears to be a different species from that of M. Hesse under the name of *Notopterophorus elongatus*,‡ which is also referred to by Dr. Giesbrecht in his remarks on the

\* Referring to this part of the animal, Hesse says:—"Le thorax est gros et court; il se divise en cinq articles à peu près de la même grandeur, sauf pourtant le dernier que est le double des autres, et que acquiert encore un volume plus considérable à mesure qu'il se remplit d'œufs, et que ceux-ci se développent par l'incubation."

† Brady, *op. cit.*, p. 144.

‡ "Beiträge zur Kenntniss der innerhalb der Ascidien lebenden parasitischen Crustaceen des Mittelmeeres." *Zeitschr. Wiss. Zool.*, Band 19, p. 127, taf. viii., fig. 6, and taf. ix., fig. 6 (1869).

Notodelphyidæ\* ; while Dr. Canu, referring to the distribution of this species, speaks of it as occurring in the Mediterranean, the English Channel (Manche), and the North Sea.† Dr. G. S. Brady records the occurrence of one or two specimens of *Notopterophorus elongatus* amongst some things sent to him by the Rev. A. M. Norman, but which were lost during examination and before they were described and figured.‡ Possibly the form described here should be referred to the same species, and ultimately this may be necessary. Meantime, however, I am inclined to identify it with the form described by M. Hesse.

In the figure of *Notopterophorus elongatus* given by Dr. Bucholz (fig. 6A, pl. viii.) in the work referred to in the footnote, the dorsal appendages are without whip-like filaments; and the excellent drawings of the same form in plate xxiii. of Dr. Giesbrecht's *Beiträge* represent these appendages as bearing minute hairs instead of the long filaments seen in *N. papilio*.

Tribe Caligoida.

Fam. Caligidæ.

Genus *Nogagus*, Leach (1819).

*Nogagus latus*, sp. n. Pl. xv., figs. 1-9 (♂).

This species and the one to be immediately described are both males, and are for the present referred to the genus *Nogagus*, Leach; they were observed on dog-fishes captured in the North Sea.

The genus *Nogagus* is not a satisfactory one, and though meantime allowed to stand, is not considered valid. The various forms that have been included in this genus are all of them males, and are supposed to belong to other genera, of which the females only are known, i.e., *Pandarus*, Leach, *Dinemoura*, Baird, *Echthrogaleus*, Stp. and Lüthrk, etc., and a few of them have already turned out to be the males of such genera.

The males and females of those species that have already been satisfactorily identified—as, for example, *Pandarus carchariæ*, Leach (the female), and *Nogagus Cranchi*, Van Beneden (the male)—are so unlike each other, not only in general appearance, but also to some extent in structure, that it is difficult to believe, without having sufficient proof of their identity, that they can belong to the same species. Yet it seems to be the case, in these examples at least, that the difference between them, though so pronounced, is only sexual, and due probably to a difference in the habits of the animals, the male perhaps living a more free life than the female.

Steenstrup and Lütken divided the *Nagagi* into two groups, the chief differences between them being that in the first the urosome (abdomen) and both branches of the first four pairs of thoracic feet consist of two articulations, while in the second the urosome and both branches of the fourth pair of feet are uni-articulate.

One of the forms now to be described—the one named above—appears to be referable to the first group, but the other differs slightly from both.

\* "Beiträge zur Kenntniss einiger Notodelphyiden." *Mith. Zool., Stat. Neapel*, 3 Band, pp. 327, 328, taf. xxii.-xxiv. (1882).

† "Les Copépodes du Boulonnais." *Trav. du Laborat. de Zool. Mar. des Wimeroux-Ambleteuse (Pas-de-Calais)*, Tome vi., p. 191 (1892).

‡ "British Copepoda," vol. i., p. 144.



This form—*Nogagus latus*—has a close general resemblance to *Caligus*, except that the frontal plates are without *lunulæ*. The cephalic shield is sub-rotundate, being nearly as broad as it is long, and it is also nearly equal to two-thirds of the entire length of the animal. The fourth and fifth thoracic segments are short but of moderate width; the last is about twice the length of the preceding segment and is sub-quadrate in outline. The urosome is small and appears to be composed of two segments. The furcal joints are also short and broad, while the apical setæ have the appearance of small lamelliform plates fringed with delicate hairs (fig. 1).

The antennules are moderately stout, and the first joint is furnished with a number of short and stout plumose bristles round the distal end, but the second joint is smaller and bears a few apical spines (fig. 2).

The second antennules are also stout, and they are each armed with a strong terminal claw (fig. 3).

The first pair of maxillipeds are considerably elongated and resemble nearly the same appendages in *Nogagus borealis*, Stp. and Ltk. (fig. 4).

The second maxillipeds are short and very robust, their distal end is moderately truncate, and they are each armed with a short but strong terminal claw (fig. 5).

The first pair of thoracic feet have both branches short, sub-equal, and two-jointed; each branch is provided with three stout and moderately elongated terminal setæ, the outer branch having also a few short spines on the exterior margin, as shown in the drawing (fig. 6).

The second pair is rather more robust than the first, both branches being two-jointed and of nearly equal length. The first joint of the inner branch has one plumose seta on the inner margin, while the second bears seven or eight similar setæ round its distal end. The first joint of the outer branch is also furnished with a seta on the inner margin and a small spine on the outer distal angle, but the end joint carries five setæ round the inner margin and apex and four spines on the exterior edge (fig. 7).

The third pair, which, like the first and second, has both branches bi-articulated, is also moderately stout, but the branches, though armed nearly as in the second pair, are rather shorter (fig. 8).

The structure of the fourth pair is similar to that of the other three, but this pair is rather smaller, and both branches are very short. One seta springs from the inner distal angle of the first joint of the inner branch, while the second joint carries three or four round the distal end. The first joint of the outer branch is provided with a small spine exteriorly, while the end joint has five setæ round the inner margin and apex, and three or four small spines on the outer margin (fig. 9).

*Habitat*.—On piked dog-fish (*Squalus acanthias*) captured in the North Sea in 1902.

*Nogagus ambiguus*, sp. n. Pl. xv., figs. 10–17 (♂)

In this species the cephalic shield is of an oval outline, and the lateral margins where they meet anteriorly form a more or less distinctly angular instead of a broadly rounded front, as in the form just described. The last two thoracic segments are of nearly equal size, and their width is about one-third of that of the cephalic shield at its widest part. The urosome (abdomen) consists of one small segment, and the furcal joints, which are also very short, are each furnished with moderately long plumose setæ (fig. 10).

The antennules, which are of average size, are also adorned with long plumose setæ (fig. 11).

The first maxillipeds are elongated, and each is armed with a long and powerful terminal claw having a stout seta at its base nearly as in *Nogagus lunatus*, Stp. and Ltk.—a species which this form resembles in some other particulars (fig. 12).

The second maxillipeds are short and very stout, and armed with strong terminal claws as shown in the drawing (fig. 13).

The first four pairs of thoracic feet are composed of two sub-equal branches, and both branches in each of the first three pairs are distinctly two-jointed. In the first pair the end joints carry three long plumose setæ, the end joints of the outer branches being also provided with four spines on the exterior margin (fig. 14).

The second pair are nearly similar in structure and armature to the second pair in *Nogagus latus* (fig. 15).

The third pair also resembles the same pair in that species, but the spines on the exterior edge of the outer branch are rather stronger, and the second joints of both branches are provided with only four elongated though stout terminal setæ (fig. 16).

The fourth pair are rather small, and the inner branch is bi-articulate; a seta springs from the inner distal angle of the first joint, and the second carries three terminal setæ. The outer branch, which appears to consist of two coalescent joints, with the articulation between them obsolete or nearly so, bears three setæ round the inner distal margin, and four spines—three small and one moderately large—on the exterior edge; the setæ are all elongated and plumose (fig. 17).

*Habitat*.—Taken from a piked dog-fish (*Squalus acanthius*) captured in the North Sea in 1902.

Genus *Dinemoura*, Latreille (1829).

*Dinemoura producta* (O. F. Müller). Pl. xv., figs. 18–20 (♀).

This species was recorded in Part III. of the *Eighteenth Annual Report of the Fishery Board of Scotland*, and I now supplement the previous description by the following additional note:—The antennules, as shown by the drawing (fig. 18), resemble in their armature those of *Nogagus latus* just described. The first pair of thoracic feet are of a peculiar structure; the inner branch is small, and it and the second basal joint bear a few small rounded wart-like processes. The outer branch has the first joint expanded and gibbous at the proximal end exteriorly, while the distal end is produced so as to extend partly over the small rounded second joint. Both branches are furnished with three marginal or sub-terminal arcuate setæ (fig. 19).

The second pair, which is also slightly distorted, has both branches three-jointed and of about equal length. The drawing (fig. 20) shows the structure and armature of this pair.

This species has been obtained occasionally on Porbeagle sharks landed at the Aberdeen Fish-market.

Another species usually found on the Porbeagle shark, viz., *Echthrogaleus coleoptratus*, has also been obtained adhering to the dorsal fin of a piked dog-fish that was captured in the Moray Firth in October, 1900. I do not know of any previous record of *Echthrogaleus* from this fish.

EXPLANATION OF THE PLATES.

PLATE XIII.

*Harriettella simulans*, T. Scott.

Diam.

Fig. 1.	Male, dorsal view, -	-	-	-	-	x	260
Fig. 2.	Antennule of male, -	-	-	-	-	x	546
Fig. 3.	Foot of second pair, male, -	-	-	-	-	x	546
Fig. 4.	Foot of fourth pair, female, -	-	-	-	-	x	820
Fig. 5.	Foot of fourth pair, male, -	-	-	-	-	x	820

*Laophontodes typicus*, T. Scott.

Fig. 6.	Female, dorsal view, -	-	-	-	-	x	260
Fig. 7.	Antennule of male, -	-	-	-	-	x	520
Fig. 8.	Mandible and palp, -	-	-	-	-	x	780
Fig. 9.	Maxilla, -	-	-	-	-	x	780
Fig. 10.	First maxilliped, -	-	-	-	-	x	780
Fig. 11.	Foot of first pair, male and female, -	-	-	-	-	x	820
Fig. 12.	Foot of third pair, male, -	-	-	-	-	x	546
Fig. 13.	Foot of fourth pair, male and female, -	-	-	-	-	x	546
Fig. 14.	Foot of fifth pair, female, -	-	-	-	-	x	542
Fig. 15.	Foot of fifth pair, male, -	-	-	-	-	x	546

PLATE XIV.

*Notopterophorus (c) papilio*, M. Hesse.

Fig. 1.	Female, side view, -	-	-	-	-	x	20
Fig. 2.	The same, dorsal view, -	-	-	-	-	x	20
Fig. 3.	Young female with a male adhering to it, -	-	-	-	-	x	47
Fig. 4.	Antennule of female, -	-	-	-	-	x	410
Fig. 5.	Antennule of male, -	-	-	-	-	x	410
Fig. 6.	Antenna of female, -	-	-	-	-	x	205
Fig. 7.	Antenna of male, -	-	-	-	-	x	410
Fig. 8.	Mandible and palp, -	-	-	-	-	x	123
Fig. 9.	Maxilla, -	-	-	-	-	x	205
Fig. 10.	First maxilliped, -	-	-	-	-	x	205
Fig. 11.	Second maxilliped, -	-	-	-	-	x	137
Fig. 12.	Foot of first pair, female, -	-	-	-	-	x	71
Fig. 13.	Foot of first pair, male, -	-	-	-	-	x	270
Fig. 14.	Foot of second pair, female, -	-	-	-	-	x	72
Fig. 15.	Foot of second pair, male, -	-	-	-	-	x	270
Fig. 16.	Foot of third pair, female, -	-	-	-	-	x	72
Fig. 17.	Foot of fourth pair, male, -	-	-	-	-	x	456
Fig. 18.	Foot of fifth pair, female, -	-	-	-	-	x	340
Fig. 19.	One of the furcal joints, -	-	-	-	-	x	270

PLATE XV.

*Nogagus latus*, sp. n.

Fig. 1.	Male, dorsal view, -	-	-	-	-	x	20
Fig. 2.	Antennule of the same, -	-	-	-	-	x	120
Fig. 3.	Antenna, -	-	-	-	-	x	90
Fig. 4.	First maxilliped, -	-	-	-	-	x	90
Fig. 5.	Second maxilliped, -	-	-	-	-	x	60
Fig. 6.	Foot of first pair, -	-	-	-	-	x	90
Fig. 7.	Foot of second pair, -	-	-	-	-	x	60
Fig. 8.	Foot of third pair, -	-	-	-	-	x	45
Fig. 9.	Foot of fourth pair, -	-	-	-	-	x	20

*Nogagus ambiguus*, sp. n.

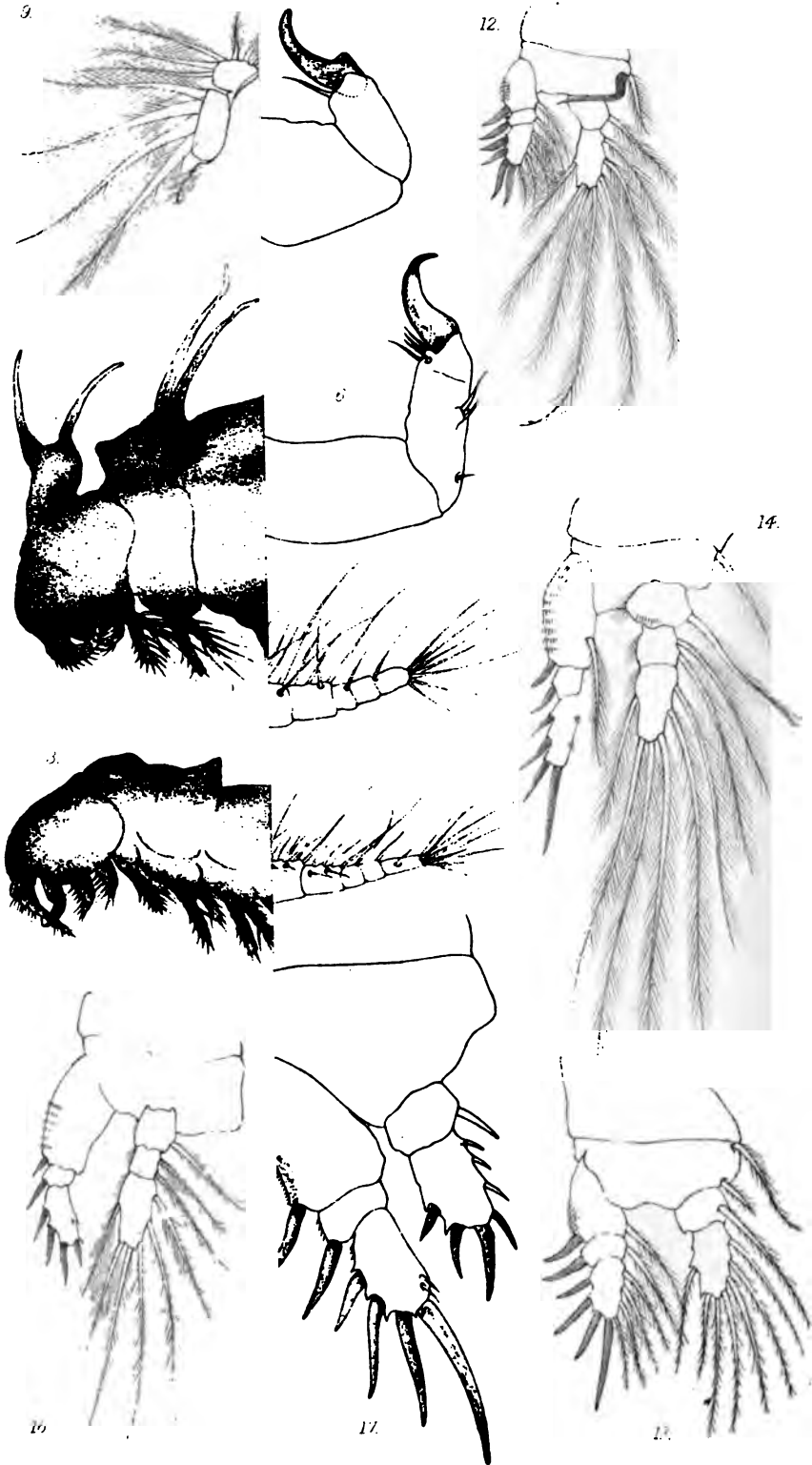
							Diam.
Fig. 10.	Male, dorsal view, -	-	-	-	-	-	× 20
Fig. 11.	Antennule of the same, -	-	-	-	-	-	× 90
Fig. 12.	First maxilliped, -	-	-	-	-	-	× 90
Fig. 13.	Second maxilliped, -	-	-	-	-	-	× 60
Fig. 14.	Foot of first pair, -	-	-	-	-	-	× 45
Fig. 15.	Foot of second pair, -	-	-	-	-	-	× 30
Fig. 16.	Foot of third pair, -	-	-	-	-	-	× 45
Fig. 17.	Foot of fourth pair, -	-	-	-	-	-	× 45

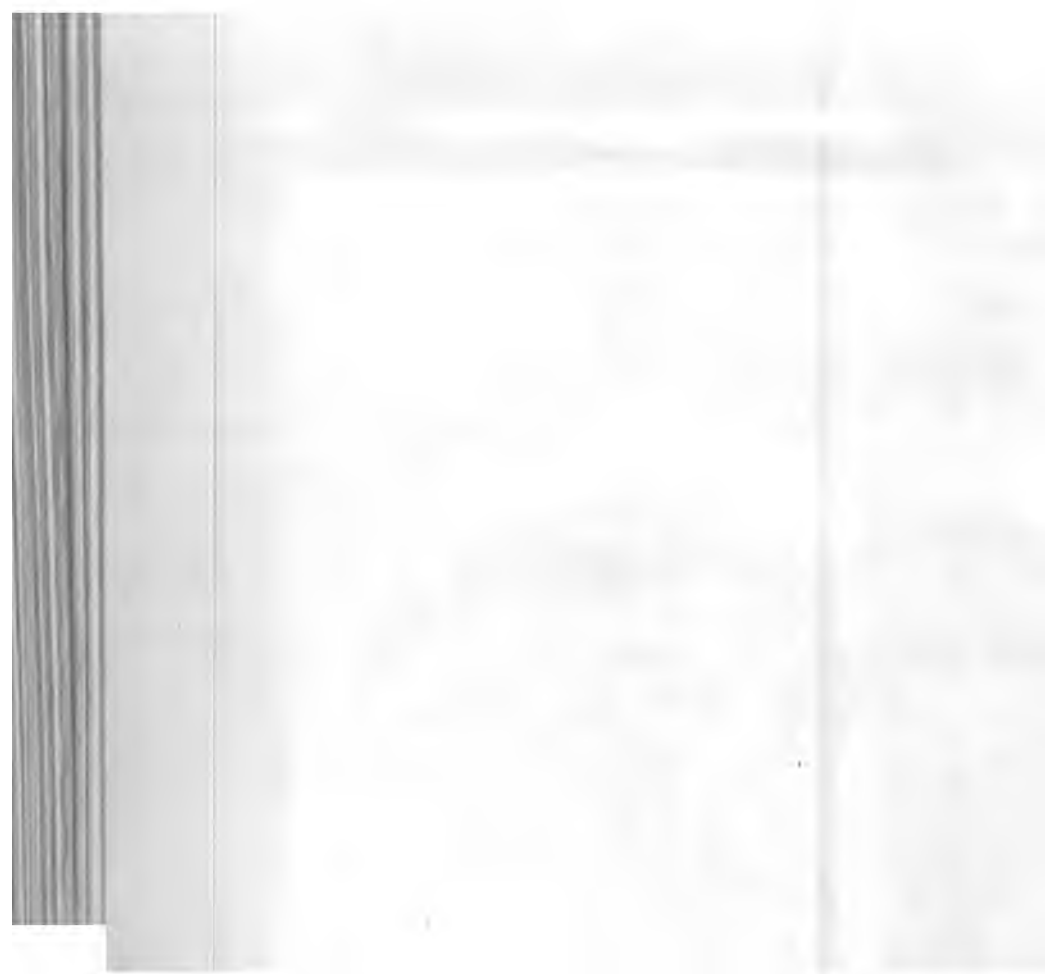
*Dinemoura producta* (O. F. Müller).

Fig. 18.	Antennule of female, -	-	-	-	-	-	× 40
Fig. 19.	Foot of first pair of same, -	-	-	-	-	-	× 26
Fig. 20.	Foot of second pair, -	-	-	-	-	-	× 13

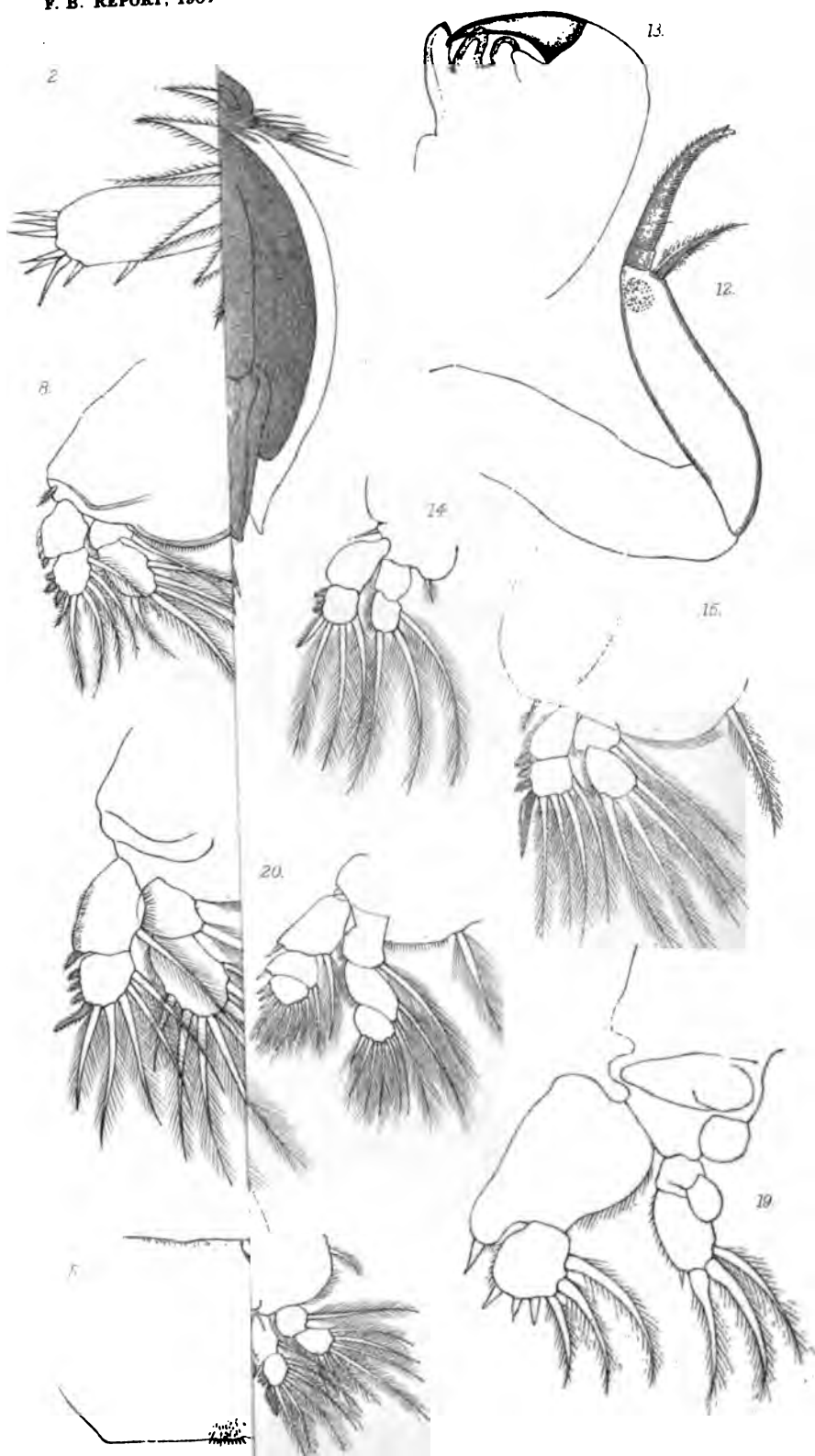














IV.—THE SPAWNING, GROWTH, AND MOVEMENT OF THE  
MUSSEL (*MYTILUS EDULIS*, L.), HORSE-MUSSEL  
(*MODIOLUS MODIOLUS*, L.) AND THE SPOUTFISH  
(*SOLEN SILIQUA*, L.) By H. CHAS. WILLIAMSON, M.A., D.Sc.,  
Marine Laboratory, Aberdeen.

(Plates XVI.–XX.)

CONTENTS.

	PAGE
The Development of the Reproductive Organs, . . . . .	221
Spawning, . . . . .	228
Growth, . . . . .	233
Movement, . . . . .	242
Structure of Foot, . . . . .	244
Structure of Byssus-Pit, . . . . .	247
The Byssus-Stem, . . . . .	250
Formation of Byssus-Stem, . . . . .	251
Growth of the Spoutfish, . . . . .	251
Literature, . . . . .	252
Explanation of Plates, . . . . .	253

During the past three years I have carried on certain experiments bearing on the natural history of the Mussel, and the results are embodied in the following pages.

There is an extensive literature on the mussel and its culture, and, notwithstanding that fact, there are various points in its life-history which require further elucidation. While the development has been studied by several authors, especially by Wilson, there are still blanks in the early life-history. And many of the causes which influence the well-being of the mussel in different localities are not clearly defined.

The facts which I am able to communicate extend our knowledge of the spawning, growth, and movement of the shell-fish.

I shall first of all discuss the development of the reproductive organs, and the appearance of the mussel in different months of the year.

*The Development of the Reproductive Organs.*

In the quiescent period, according to Wilson, the mantle lobes are delicate and transparent. "The follicles are racemose outgrowths of the minor genital cauals, . . . and they may be observed pushing their way in the mantle until they reach nearly to the pallial muscle. With a little experience it is possible to detect the sex of the specimen, the darker orange tinge and the less distinctly botryoidal arrangement of the female, as contrasted with the male glands, being usually marked. The colour may be almost absent in comparatively young forms of both sexes. The genital ducts lie mostly toward the outer side of the mantle. Where the branches enter the follicle they may have ciliated columnar epithelium on the one side and germinal epithelium on the other. The genital tube is one of two common ducts which pass to the outside."

The mussels examined in the Laboratory have been obtained from two sources mainly, viz., from Mr. Allan, mussel merchant, Torry, and from the sides of the pond at the Bay of Nigg. The description of the mussels may be conveniently taken under the denomination of the month, and, beginning with September, that arrangement will be followed.

**SEPTEMBER.**—The mussels obtained from the side of the pond were fat, and had in the majority of cases yellow-coloured mantles. This colour appears to be due to fat. One or two had thin dark-orange mantles; they are probably spent, or mussels that had not yet fattened.

From a lot supplied by the merchant, two fat mussels were examined. In one the mantle was cream-coloured; in the other it was much paler. Under the microscope very small spherical corpuscles were seen along with broken ground tissue. One or two of the corpuscles had a slight motion.

**NOVEMBER 19, 1906.**—Some mussels measuring up to  $1\frac{1}{2}$  inches in length were obtained from the walls of the upper reservoir tank. They were in poor condition, with translucent mantles. The two sexes were distinguished with difficulty. Two different classes were noted—one in which the mantle and the abdomen were of a yellow colour; the other in which the same parts are slightly orange-coloured. Brown veinings are seen in the mantle of the latter. These brown veins are lined with cilia, in parts at least, and are filled with brown corpuscles, which, varying in size, debouch from the cut ends of the canals. There are also in the tissue of the mantle little colourless ovoid bodies which, under a high power, are seen to consist of several cells enclosed in an envelope. Under medium and low powers the groups are egg-like. In the other mussel the canals are, by reflected light, of a light yellow colour; by transmitted light they are dark. They are wide, and packed with small round cells. When pressed out of the canal they are accompanied by small oscillating corpuscles. There are numbers of small cells between the canals differently arranged from the former mussel.

**NOVEMBER 27, 1906.**—Mussels were obtained from the big pond. They are fat, and show various conditions. Some of them had white mantles. These, certain local fishermen considered to be better for bait than the yellow mantle. They regard the yellow mantle as indicating spawning.

There were mussels showing mantles of intermediate shades of colouring between the white and deep yellow or cream. The white and light cream mantles have colourless veining. Others, dark cream in colour, have brown veinings and amber spots. In one large mussel the mantle was of a light cream-colour, with amber-coloured veins, and it had its surface mottled with amber. The amber colour is due to minute amber-coloured cells of various sizes, some of them being fairly large oval cells with nuclei. There is also present a great quantity of refractive corpuscles. In the case of the deep-cream mantle, the ground is white with an amber mottling developed over it. In the light-cream mantle the brown cells are absent, but clear cells containing what resemble the heads of spermis were observed. The veining and mottling are rather colourless.

**NOVEMBER 19, 1906.**—The mussels supplied were principally fat, with heavy thick mantle, white or yellow in colour. Some small mussels had pale thin mantles coloured brown, showing brown veinings with little brown corpuscles. The white mantle when teased out showed clear round cells with large nucleus and pitcher-like cells crowded with small refractive corpuscles mixed with small fat corpuscles. Great numbers of small refractive corpuscles were free. The veins were colourless. A

second mussel had a cream-coloured mantle. It had brown veins, and was crowded with minute corpuscles which looked like the heads of sperms.

DECEMBER 15, 1906.—The mussels supplied by the merchant were of two distinct colours, viz., (1) light cream mantle, and (2) dark cream, inclining to orange. In the first class, on teasing a portion a white fluid is obtained that coagulates on the addition of fresh-water. The mantle consists of a very slight stringy tissue; hardly any basement or ground-work tissue is made out. The principal constituent is very minute oscillating corpuscles (fat) and pitcher-shaped cells full of larger corpuscles. Some round cells with large nucleus and nucleolus were also noticed. In one or two of the main vessels little brown patches were seen.

In the second lot a slight milkiness, due to fatty corpuscles, was obtained on teasing a portion of the mantle. Pouches were made out, with large dividing cells, and also some bodies apparently glandular, showing a central cavity and a great number of minute cells.

JANUARY 21, 1907.—On this date the mussels supplied to the Laboratory were separated into two classes by the colour of the mantles—(1) a cream-coloured mantle, and (2), an orange-coloured mantle. There are others which have a pink-cream hue. Some have thin orange-coloured mantles. In large specimens the orange-coloured mantles are thick, and show traces of a creamy-coloured base.

On cutting into the creamy-white mantle a pale white fluid issues. Under the microscope it is seen to consist of ruptured thin-walled capsules, and there are also minute bead-like corpuscles and oil corpuscles.

In the orange mantle there are little brown cells of various sizes mostly minute. They show a nucleus.

The mantle of a small mussel was full of brown capsules filled with brown corpuscles of various sizes, and also of colourless corpuscles. The brown corpuscles are in most cases very small; some larger were seen to be dividing. The brown corpuscles are attached in little groups. There is a colourless connective tissue with long cells and an apparently albuminous blood-fluid. The capsules appear to be full of an albuminous corpusculated fluid, in which the brown corpuscles are growing.

In the large mussels the capsules are not so brown, but the brown corpuscles are dividing. There are also present colourless cells with nuclei.

FEBRUARY 27, 1907.—The mussels were now distinctly yellow (male) and red-coloured (female). The red colour was in various stages.

The male mussel was not very far advanced; the spermatophores contain round corpuscles, which oscillated very vigorously; they were of all sizes.

APRIL 11, 1907.—Some mussels that were shelled on the previous day were examined on this date. The cilia in some were still working.

The male had a pale mantle with the spermaries forming a prominent white granular layer on it. The paler part is seen to be divided up with pale-coloured spermaries, and there are sacs full of sperms, not quite so large as the white sacs. The white sacs are large and more widely separated from one another than are the egg-sacs in the female.

In some females the ground-work of the mantle is orange-coloured; the ovaries are white. The fringe of the mantle is distinctly orange-coloured, and shows brown bodies in vessels. In another female the mantle was not orange-coloured, but it had small closely-packed egg-cases and similar brown bodies. The eggs are quite white, pitcher-shaped, with a well-marked nucleus, possessing a nucleolus. The nucleus, as Wilson pointed

out, appears to have a distinct cell-wall. The egg is oval and measures about 0.7mm in diameter; it is filled with yolk granules. The nucleus, according to McIntosh, shows as a cleared part in the midst of the egg. In some cases it is burst clear out of the egg, and can be seen as a clear circular body with a prominent nucleolus. It measures 0.5mm. and less in diameter.

Seen alongside the mantle of the male, that of one female, with its ovisacs had a very slight cream colouration.

In the female the ovisacs were more equally developed, *inter se*, in contrast with the two distinct stages of development in the same mantle of the male. The latter fact will bear upon the question of the duration of the spawning period, and the possibility of the mussel spawning twice during the same season.

In one mussel which had a thin orange-coloured mantle, I was unable to make out definite sexual elements.

APRIL 15, 1907.—Some mussels that were taken from the wall of the big pond had been kept in a sunk box.

On opening them they were found to be fat. The sexes were very distinct. The male had a deep cream-coloured mantle and abdomen. The female was of a chocolate-pink.

The sperm-sacs were distinct—white. The vessels in the mantle were translucent—amber. On cutting into the mantle a milky fluid issued. The sperms were alive, and, under Zeiss Obj. D.D. : oc. 4, showed fairly large.

In the female the ovisacs were only distinguished with difficulty in the general ground of the mantle. The vessels were similar to those in the male. On teasing the mantle the eggs were obtained, but in most cases they were burst. They were oval, round, or pear-shaped, measuring 0.7-1mm. in diameter. There is a large pore in the zona, and by it the yolk corpuscles pour out. The yolk granules wriggle about; they are smaller than the sperms. I was not able to make out any connection of the eggs to the ovarian tissue, even when they were sticking together *en masse*. The pore in the zona is a clean-cut hole. The pressure of the cover glass in some cases forces out the nucleus, although it is of greater diameter than the opening. In other cases the nucleus remains inside while the yolk granules nearly all pour out. The nucleus retains its shape after it issues from the pore. It exhibits a slight granular structure. Sometimes there are a few yolk granules attached to it. Occasionally the nucleus is accompanied by what appears to be a little nucleus.

The gills and labial palps in both sexes are sometimes orange-coloured; in the female rather darker than in the male. In the latter sex, however, they are also found colourless.

APRIL 29, 1907.—The mussels supplied at this date were not apparently so far advanced as some already examined.

Some of them were fat and yellow in colour. On dissecting, a pale white fluid was got; it is albuminous, and coagulates on the slide when fresh water is added. It contained small round corpuscles, and cells full of dark refractive corpuscles.

The other mussels were pale and of a slight orange tinge, having thin mantles. In them were observed pitcher-shaped cells showing a clear nucleus. The eggs are not very far developed.

MAY 1, 1906.—The mussels on this date were nearly all pink. They were females with well-developed ova. The pink region is the mantle, which is almost wholly that colour.

MAY 31, 1907.—Some mussels were covered with barnacles. They were not fat. The mantles were thin, having a clear ground tissue, and reproductive organs nearly ripe.

JUNE 3, 1987.—Some pond mussels had been kept in aquaria in order that the spawn might be observed. Up till this date none had been noticed. The mussels were examined and found to have red ovaries. The yolk granules poured out of the egg. The zona appeared to be two-layered. The nucleus seemed to be simply a naked sphere of clear protoplasm. Sperms were obtained from a dirty-yellow or amber-coloured mantle.

JUNE 25, 1907.—Some mussels were obtained through the kindness of Professor M'Intosh, from St. Andrews.

The mantle of the mussel had its central part filled with reproductive elements, but showed surrounding that portion a more or less broad clear margin. In the female the sexual part was orange-coloured, and in the male whitish. A larger proportion of the mantle was, in most of the cases examined, filled in the female than in the male. The thin dark-orange mantle (female) showed little white bodies all over the orange groundwork. In the male the white bodies were not so distinct, but larger, measuring about  $\frac{1}{32}$ -inch. The eggs were of the usual type of the unripe egg, having a big pore from which the yolk granules pour, and having a nucleus with a sharp outline. The zona was all crumpled, and evidently consisted of two layers.

In the spermaries there were bodies similar to the heads of sperms consisting of a circular head with a tapering manubrium-like prolongation. Several groups of these were seen united by the ends of their manubria.

JUNE 28, 1907.—Some of the St. Andrews mussels were examined on this date. Several males measured from 2 ins. to  $2\frac{3}{8}$  ins. in length. The mantle was about  $\frac{3}{2}$ -inch in thickness, and was only partly occupied with reproductive organs. The females, measuring  $3\frac{1}{2}$  ins. to  $3\frac{1}{4}$  ins., showed thin mantles, which, as in the males, were not fully occupied by the ovaries.

JULY 16, 1907.—A mussel which was examined on this date had red ovaries approaching ripeness. The reproductive organs were restricted to part of the mantle.

JULY 19, 1907.—Six mussels from the pond were examined on this date. They belong to the lot which was sampled in April. They measured from 2- $2\frac{3}{8}$  inches. One of them is shown in figs. 103 and 104. Five were males, the sixth was a female.

The mantle of the male mussels was in some cases of a light cream colour, in others of a dark cream colour. Practically the whole of the mantle, with the exception of a small portion at the anterior lower side, was occupied with the cream-coloured organs. The mantle was about  $\frac{1}{2}$ th inch in thickness. The organ is thinner towards the margin. The spermaries were not so prominent. The mantle shows an uniform cream-coloured surface, which under a lens is seen to be broken up into little roundish bodies. It differs from the condition seen earlier in the year. On cutting into the mantle a whiteish fluid issued; it consisted wholly of ripe sperms. Where a portion of the tissue was teased and pressed out under a cover-glass a delicate network tissue which resembles vessels, and having associated with it groups of the heads of sperms stuck together, was made out. The sperm heads had the manubrium-like process but no tails. The tissue consists of vessels, stringy fibres, and fairly large pouches crowded with heads of sperms. There are also some round cells in the pouch; they are larger than the heads of the sperms: they may be gland cells on the wall of the pouch. On dissecting the abdominal process ripe sperms, with tails, clear corporules (fat), and groups of cells showing granular contents were found;

they were massed together or separate—probably glandular. The veins were of a dark amber colour.

The female mussel had a mantle of an uniform light-pink colour. Although it is fuller than in the mussels examined in June, it is not completely filled. It was about  $\frac{3}{4}$ th of an inch in thickness. On cutting into the mantle a pink or red-ochre fluid was obtained. It consisted of eggs (most of which were partially or wholly emptied of their yolk contents), reddish yolk corpuscles, and nuclei. All the eggs had a distinct pore in the zona; it varied in size, and had ragged edges in some cases as if it had been torn away from some attachment (fig 12). The nuclei are very ductile, as they pass out through an opening smaller than their own diameter. They have a sharp outline, with a distinct hyaline outside layer; the contents are granular, and enclose sometimes a nucleolus. In no case did the nucleus show a ruptured or crumpled wall. In some cases the nucleus (n) plugs the pore (fig 35). The eggs are arranged in a pouch which seems to be an expansion of a large vessel. The egg would appear to be attached by its outer layer to the inside wall of the pouch. When the egg is torn from its attachment the yolk granules usually pour out, although it is not so in every case; *vide* fig. 12, where the inner layer of the zona is evidently preventing the escape of the yolk. The inner layer appears to be very delicate. The outside of the pouch was also supplied with what looked like vessels. The mantle tissue on teasing is reduced to eggs and a stringy material, probably vessels. There is no evident amount of fat. In the abdominal process were found eggs, and some round cells with granular contents and others with brown granules. The round cells are in total size only about equal to the nucleus of the egg. Under a high power the yolk granules are amber-coloured.

These mussels were judged to be of good quality from the fishing point of view. By one authority they were referred to as "fatty mussels" (figs. 93 and 95).

Another of these mussels had a mantle which in general colour resembled a peach. It had a cream-coloured ground, with an amber mottling. The eggs were amber in colour.

SEPT. 2, 1907.—The mussels supplied at this date by the merchant were, in respect to the mantle, coloured white in some cases, cream in others, and in a proportion orange-cream.

The white mantle had a slight cream tinge. It was not thick, only  $\frac{1}{8}$ -inch. Under the lens it showed a close white network with translucent amber-coloured spaces between. Owing to the great development of the white branching in the inferior half of the mantle, the translucent parts are merely dots there. In the superior portion, that next its attachment to the organ of Bojanus, the branching is less close and the spaces bigger. The white branching extends over the organ of Bojanus in close connection with the surface vessels: it is along each side of the vessels and their branches. The vessels in the mantle are translucent, and their branching forms a translucent network. There are a few small patches of amber-coloured corpuscles on the superior part of the mantle, near the posterior adductor. On teasing a portion of the mantle, nothing was made out except a mass of minute corpuscles bound with connective tissue, and a few groups of amber-coloured bodies. In a portion from the superior part of the mantle there was, in addition to the above, some transparent bodies, certain of which showed part granular contents and more or less irregular outline.

Up till November 2, mussels containing ripe sperms and full-sized eggs were obtained. On this date the ovaries could still be made out on the



surface of the mantle in one specimen. The reproductive elements were, however, usually hid by the fat condition of the mantle. The mussels which contained ripe sperms had mantles of the following colours:—white, light cream, and deep cream. In the females containing full-sized eggs the mantles were coloured white, cream, and yellow, with, in each case, a pinkish tinge, and dark-red. When the mantle of the male mussel is cut across the section is yellow, and from it a white fluid oozes. In the female the section is brown-mottled.

On November 2, two females were examined in which the reproductive organs were quiescent. In the first case the mantle was of a deep orange-red or chocolate, a colour nearly resembling that of a ripe mussel. The tissue was mottled with brown corpuscles. The body fluid that issued on teasing a portion of the mantle consisted of minute clear drops. In the second case the mantle was of a light yellow colour.

M'Intosh examined mussels from January to July. In January "the mantle was, when compared with an undeveloped specimen, considerably thicker. A male measuring  $3\frac{1}{2}$  inches in length presented in the thickened generative region large, pale, round sperm-sacs filled with minute spermatozoa, which have minute ovoid bodies with finely filamentous tails. They are lively and tenacious of life. . . . The female had the same region of the mantle crowded with a prodigious number of minute ova. In shape they are ovoid, with a transparent investment and an inner granular yolk with a pale circular area. In February the mantle . . . increased considerably in thickness. The whole surface of the mantle became speckled in both sexes with the reproductive elements. . . . The mantle in one case had increased in thickness to about  $\frac{3}{4}$ -inch, and the development of the sperm-sacs seemed to proceed from the dorsal to the ventral edge of the mantle. Even in specimens in which the shell has been injured and the mantle remains thin at certain places, an immense number of ova are developed. After full maturity is obtained, as in April, the orange mantle is richly marked in an aborescent manner by racemose sperm-sacs and ducts, especially towards the margin, and when the mantle is swollen out with water the sperm-sacs project like bunches of grapes. In the female this appearance is not so evident, for the ova are grouped in masses of a circular or ovoid form and densely packed. The females at the end of May now contained comparatively few ova, and the mantle had diminished considerably in thickness. Much granular brownish pigment was present in the latter. On the 9th June the female mussels still showed some ova in the thickened dorsal region of the mantle, but the margins were pale and thin. As before, much brownish pigment was present. In July the dendritic appearance of the salmon-coloured mantle was less marked, and neither ova nor spermatozoa could be distinguished microscopically. The general stroma was granular and minutely cellular, as if a general resolution of the tissue were taking place, and the characteristics of the sexes were absent."

The eggs would, then, appear to be derived from the minute brown-coloured cells seen in the mantle of the unripe mussel. The thick fat mantle is not a necessary precursor to reproductive activity. The little brown cells seem to be supplied with chlorophyll, and are found at the end of the year in thin mantles as well as in fat mantles. Any one lot of mussels consists usually of a mixture of fat and thin mantles, showing that even where the water may be abundantly supplied with food some mussels may still, from the accident of their situation, be starved. In one case the sample may show a majority of fat, in another a majority of thin mantles.

*Maturity and Spawning.*

Wilson says that the mussel may become ripe when one year old. He found ripe sexual elements in mussels measuring  $\frac{1}{8}$ -inch in length. At the Bay of Nigg one mussel which was  $\frac{3}{8}$ -inch long spawned.

M'Intosh gives the spawning-time as lasting from April to June.

**SPAWNING OF THE FEMALE.**—At the Bay of Nigg mussels were observed to spawn on three occasions, viz.—(1) a mussel measuring  $2\frac{1}{4}$  inches on 6th April; (2) a second of the same size on 1st June; and (3) two mussels measuring respectively  $\frac{3}{8}$ -inch and  $1\frac{1}{4}$ -inch on June 30th.

Scott found that the mussels at Piel Laboratory spawned between the beginning of May and the middle of July. The eggs were being discharged some time before the sperms were observed, viz., 13th June. The spawning of the eggs usually took place during the night, but he had an opportunity of observing the manner in which they left the parent. "The embryos flow from the female in a slow distinct current. When not disturbed they settle down on the mud close to the parent as an obvious pink mass."

The mussel which spawned on 1st June had been brought from Klaksvig, Faroe, by Captain Sutherland, s.t. "Pointer," of Aberdeen. It was obtained on 1st May, and had been kept till May 31 in the basket in which the sounding-line is coiled. On being transferred to sea-water on that date it was found to be alive. It was a very old-looking mussel, and was covered with barnacles. Next day a quantity of white stuff was seen on the bottom of the vessel near the round end of the mussel (fig. 84). This was found to consist of eggs and some stringy tissue.

**SPAWNING OF THE MALE.**—On June 30th the current of water was stopped in a box in which there were some mussels, and in the afternoon a greyish cloud was seen towards one side of the box and extending to the surface. When a drop of the water was examined it was seen to be crowded with sperms. The sperm has a tapered point and a very long tail (fig. 24). They rush about in circles with a quivering, jerky, side-to-side motion.

On 13th June Scott observed the discharge of the sperm. It was so abundant that the water in the tank became quite turbid.

**DURATION OF SPAWNING.**—Scott maintains that practically the whole of the reproductive elements were discharged at one emission, extending from one to three hours. The same animal did not again set free any more reproductive elements. When such a spent mussel was opened and examined the whole reproductive organ was found to have collapsed.

This was not my experience in the case of the mussel that was brought from Faroe. It first extruded eggs on 1st June, and it spawned several lots up till June 5th. It may have, however, been a little irregular, since the mussel had been kept under exceptional conditions.

According to Mr. King, the mussels at Budle Bay, Northumberland, spawn in July, August, and September. In warmer seasons they spawn earlier, and *vice-versa*; 50°–60° F. is a fair heat in summer at Budle Bay. Lebour states that "Mr. Mitchell finds that there are two breeding seasons, one in Spring and one about August." Mr. Masson, Findhorn, who attended the demonstrations to fishermen at the Laboratory in 1906, informed me that in the river there the mussels empty [spawn] during a spate, and then fill up again. Red mussels (female) were more common than yellow (male). At Montrose, Fullarton and Scott report that "Mr. Johnstone was of the opinion that the mussel spats in May, June, August, and the beginning of September, while others held that the mussels spat all through the year."

**FERTILIZATION.**—M'Intosh and Wilson believe that the fertilization of the eggs takes place outside the body of the female.

Wilson effected artificial fertilization of the eggs by mincing pieces of the ripe ovary and testes separately in water and then by mixing the two fluids.

Scott considers that fertilization takes place within the female. He made some experiments to demonstrate this. At Piel the first eggs that were spawned were not fertilized. After the first discharge of sperms, however, the eggs were always fertilized.

Garner thought that the mussel was hermaphrodite and that the eggs were already fertilized when discharged.

#### *The Mature Egg.*

When the eggs are present on the bottom of the aquarium in quantity, they show a pink colour. In the case of the Faroe mussel the colour of the eggs was hid by some colourless tissue that was extruded with them.

Wilson describes the ripe egg thus:—"The mature egg after extrusion is quite spherical and very opaque, on account of the large development of deutoplasmic (vitelline) granules. The vitellus appears greenish-brown by transmitted light. The egg membrane is distinct. The nucleus and nucleolus are not visible in a normal mature egg, a less opaque region marking their position. The hyaline investment noticeable around the intra-follicular egg forms a broad, very translucent sheath to the ripe extruded eggs. It is presumably adherent to mature eggs naturally extruded—certainly so in the case of artificially-liberated ones. Many spermatozoa wriggle into it and cause the egg to rotate. No micropyle has been observed in it. If the vitelline membrane be ruptured the nucleus escapes as a spherical body bounded by a definite membrane and enclosing a nucleolus."

The eggs spawned by the Faroe mussel showed the following characters (fig. 6). They were, to the naked eye, greyish in colour with a faint amber tinge. They were round in some cases, usually oval, measuring .07 by .06; .07. One was as long as .1mm.

The yolk is seen to be broken up into several large corpuscles or divisions, and at the periphery there are minute corpuscles similar to those that are found in the developing egg.

The zona is wrinkled, corrugated on the outside, and raised into little papillæ. The corrugations seem to be due to the yolk being in large corpuscles which bore the zona. It has two definite layers, and in addition some eggs show what looks like a thin membrane on the yolk. The latter may be simply the sharp outer edge of the protoplasm. There are little protoplasmic thread-like projections from parts of the zona, possibly from pores (fig. 8). In one case a pitted condition of the zona was thought to be made out.

A faint indication of the nucleus was made out in some, and surrounding it large yolk corpuscles or divisions composed of the minute yolk corpuscles. The large nucleus seems to be broken up more or less into large round bodies.

On pressing the egg by means of the cover-glass, the contents do not flow out so readily as in an egg dissected out of the mantle in a ripening ovary. In the latter case nearly every egg exhibits the loss of some of its yolk contents.

One of the naturally spawned eggs, when pressed lightly, took a pear shape with a conical end. This seemed to be at the micropyle, and to be formed by the forcing of the egg contents to project through it.

But the egg contents, being now more cohesive, withstood the pressure without breaking up.

When the egg was crushed the yolk corpuscles poured out all oscillating, leaving no nucleus to be seen; there were some groups of corpuscles a little larger than the others. The zona retained its shape and appeared quite smooth in some, although in others it was still tuberculated.

When the egg was squeezed sufficiently to cause some of the contents to flow out, a sort of perivitelline space began to appear, formed after the escape of a quantity of yolk by the entrance of water. In the partially emptied egg there were protoplasmic threads from the remaining portion of yolk to the internal surface of the egg-shell, and the zona had lost its corrugations. Wilson gives a drawing of an egg that had apparently lost some of its contents; in it little protoplasmic threads connecting the inside of the zona to the segmented mass left inside are indicated.

The clear protoplasm of which the nucleus in the ripening egg consists appears now in the ripe egg to have extended through the yolk, binding the granular matter together, and apparently making a clear, sharp, external layer to the yolk-sphere.

When the yolk granules issued through pressure, they sometimes took up some of the clear protoplasm, and they are seen covered with a clear layer—a little entity consisting of one or many yolk corpuscles covered with a clear protoplasm (fig. 41).

Out of one egg there was pushed a clear network-like mass (fig. 7), which might have been a crumpled membrane. The egg from which it came was continually changing its shape. The "network" was seen free in another case, away from the egg.

**SUB-DIVIDING OF THE UNFERTILIZED EGG.**—Some of the eggs were kept overnight in a dish. By next day some of the eggs had given off little spherical bodies of various sizes. They were formed by the outflow of the egg contents through the micropyle.

These bodies consist of a larger or smaller number of granular yolk corpuscles surrounded by clear protoplasm. Sometimes they can be seen attached to the egg at one point like a number of little balloons attached to a large balloon. They may vary in size or may be all nearly equal (fig. 16). Changes were observed to take place in these bodies, even while the egg was examined. A dark globule was added to one egg as I watched. They become detached, and go off resembling in appearance a little egg. Although they have a sharp outline they have no cell wall (fig. 41).

During the night the eggs had been actively budding off these little spheres, so that next day it was hardly possible to treat any of the eggs in the dish as normal eggs.

Some of the eggs showed a hyaline investment, which appears to be formed by the exudation of clear protoplasm from the egg. An egg had a crumpled hyaline investment, which looked as if it were the outer zona layer which had become loosened.

**ARTIFICIAL FERTILIZATION.**—On June 3 some eggs were obtained from the mass lying near the mussel. They were motionless and unsegmented. Some of them showed a little refractive protoplasmic process on the outside of the zona.

A piece of the mantle of a male mussel was put into water. The water became milky, and when examined was found to be alive with active sperms.

Some of the fluid was put, by means of a pipette, into the dish containing the eggs. It was possible to see under the microscope the sperms whirling about among the eggs.

At 1 p.m. one of the eggs showed a number of little protoplasmic processes sticking out at right angles from the zona (fig. 8). They seem to be detached from the zona, though probably connected by a very fine protoplasmic thread, which was invisible under Zeiss DD. The sperms kept boring away, but did not seem able to get closer to the zona than as shown in fig. 8. There was a protoplasmic boss sticking out of the micropyle. This was generally present, and usually on the lower side of the egg.

One egg had its zona covered with papillæ. Another had three or four sperms stuck with their pointed ends against the zona. A clear layer outside the zona was made out in one egg; it seemed to me merely an exudation of protoplasm.

The inner of the two zona layers is applied close to the yolk, as is shown by the protoplasmic boss, which is constricted by it (fig. 18). A narrow clear division is seen between the two layers of the zona.

At 3 p.m. segmentation had occurred in several eggs. In one egg the division into two was proceeding from one side (fig. 10). Another egg was segmented into a macromere and a micromere; the protoplasmic boss was on the macromere (fig. 21). Sometimes it stands right across the dividing line. Figs. 10, 11, 13, 20, 21, 22, 28, and 29 represent conditions found at 3 p.m. Most of the eggs were in the two-celled stage (fig. 13).

Some eggs had taken a kidney-shape, having a hilum deeply inserted (fig. 20). The niche was filled up partly with translucent material. The zona seems to thin away over the notch sometimes. The division of the egg takes place within the zona, and is not apparently taken part in by the zona.

In the two-celled stage, one egg after being quashed retained its previous two-celled shape (fig. 38). A nucleus was seen in it; it simply showed a little sphere with yolk granules attached. Round the inside of the investment there was a number of small clear corpuscles larger than yolk granules. The yolk granules when poured out oscillated.

In one case of crushing the egg I saw some clear protoplasm of yolk granules after they issued form into a sphere exactly resembling a nucleus. The yolk corpuscles caused the "nucleus" to quiver. Then the excess of yolk granules moved away from it.

The nucleus seems to mean simply a collection of clear protoplasm in the centre of the cell. It may, on the egg being crushed, break up, or it may retain its shape after the yolk granules have poured out. In the developing egg the nucleus is not intimately bound to the yolk granules; in the ripe egg it is distributed through the egg mass.

In a three-celled stage a little clearer area in the centre indicated the presence of a nucleus in each cell (fig. 17). When the eggs were crushed the nuclei were seen to be similar to the nucleus of the ripening egg—a clear vesicle-like body showing no structure under Zeiss D.U. and oc. 2 (fig. 14). The nuclei were visible externally first in the three-celled stage.

Division into four cells was noticed (fig. 30).

At 7 p.m. development had not proceeded further than at 3 p.m. Fig. 25 represents one of the eggs at that time.

By the next forenoon, the eggs in the dish had not advanced; they appeared to be dead. A number of them had a gelatinous network round them. One egg which showed a gelatinous outer network measured .06mm. in diameter; it is small, and may have lost some of its contents.

On June 5 a new lot of eggs had been spawned

**INFUSORS AND DECAYING EGGS.**—On June 10 a big heap of eggs remained near the mussel. A sample was examined. They were disorganised. There was a great quantity of very small and also big infusors among them, and the smallest infusor was not too big to get into the egg by the micropyle. They did not appear to be able to get into the egg.

Next day the infusors were quiet, apparently encrusted. On June 13, in the same dish, the infusors were big and again active. The eggs have almost altogether disappeared. I noticed infusors darting into the egg-shells, going round inside and then out again. In one egg-shell two infusors were lying still.

On June 15 the mussel was dead.

**DEVELOPMENT.**—According to Wilson—"In 20 hours or a shorter time after fertilization, the ciliated embryo rise, it may be to the very surface, in warm, calm, water. They are moved hither and thither by the currents and by their own locomotor apparatus, the cilia, and latterly the velum."

Scott observed that the embryos rose "from the bottom at the end of 12 hours. They remain free-swimming for at least four days."

Some spawn that was observed on June 30 at the Bay of Nigg was examined. The eggs were in various stages of segmentation up to the ciliated larva. The motion in the eggs and larvæ was very slight, and it is questionable if it would have been sufficient to raise them off the bottom. Some of the eggs remained on the bottom next day.

When 12 days old, the larval mussels are, Wilson says, almost semi-circular, the hinge-line being straight. In later forms, the prismatic shell-substance begins to be deposited round the margins of the valves. The growth takes place most rapidly antero-posteriorly, the mussel thus assuming the elongated characteristic form of the adult. With the advent of the prismatic shell, the velum is atrophied and the mussel sinks to the bottom or lights on seaweeds, zoophytes, etc. The foot, at first vermiform and highly extensile, is used for progression; at the proximal region of the foot the byssus-gland secretes the byssus wherewith the mussel may be anchored.

In July and August, M'Intosh observed that the surface of St. Andrews Bay swarmed with minute mussels of a somewhat circular outline and showing four branchial processes behind the foot. The young mussels, according to the same author, are found settled on zoophytes in July. At Kiel, Mobius states that the young mussels attach themselves in the latter half of June.

#### THE SPAWNING OF MODIOLUS.

**FEMALE**—February 27, 1907.—The eggs in a *Modiolus* examined were nearly ripe, and they formed a brick-red dust to the naked eye. The most of them showed a germinal vesicle in the middle of the opaque-red yolk. Lots of the eggs are pitcher or pear-shaped. They measure .1mm. in diameter. Some were ruptured.

**MALE**—June 9.—Two *Modiolus* that were kept in a tank measuring 5 feet by 4 feet by 2 feet deep, were seen to be spawning. A grey cloud was seen to spread from them over the bottom of the tank and ascend in a wide spiral up to the surface (fig. 98). The motion was due to the current of water in the tank. The cloud of sperms formed a thick layer on the surface of the water. A drop of water that was just covered by a cover-glass  $\frac{5}{8}$ -in. in diameter contained 11 spermatozoa. The sperm resembled much that of *Mytilus edulis*. Round the head there appeared a lighter ring—a sort of halo. After some time the whole of the

**SPATTING.**—Several specimens of modiolus, obtained in February 1907, were kept alive in aquaria at the Laboratory. The water flowing out of these passed into the big pond. On July 17 some twigs which had been put into the pond on April 25, 1907, for the purpose of collecting spat were found to have young modiolus attached. Some were also attached to the cord by which the twigs were anchored. The following are the sizes of the young:— $\frac{3}{8}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ ,  $\frac{1}{2}$ . They were, at most, five months of age. They were regularly scattered over the branches of the twig, and had attached themselves, no doubt, just at the end of the pelagic stage. They had not been attached three months. If the pelagic stage does not last more than a month, these horse-mussels must have been under four months of age.

The young modiolus were put into a box, which was covered with a lid to exclude the light; some were still attached to the twigs, others were free on the bottom of the box. On September 2nd some of the latter had climbed up the side of the box to the surface of the water; others remained attached to the twigs or on the bottom.

Observations bearing on the growth of this shell-fish and its behaviour under certain conditions have been made on mussels of different sizes that have been kept in the Laboratory for from one to two years.

On July 4, 1905, some mussels taken off the rocks were measured, and three lots were separated.

They were put into vessels supplied with a steady run of sea water. Mud gradually accumulated on the bottoms of the aquaria until a fairly thick layer was formed. Now and then this deposit was removed.

When examined on August 5, 1906, the mussels were found to be all of a peculiar shape, roughly barrel-shaped. They were broad laterally, convexly curved above, concave below. Their sizes were— $\frac{1}{4}$ ,  $1\frac{1}{8}$ ,  $1\frac{1}{8}$ ,  $\frac{3}{4}$ ,  $\frac{3}{4}$ ,  $\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ .

On Feby. 25, 1907, the measurements were— $\frac{5}{16}$ ,  $\frac{1}{8}$ ,  $\frac{3}{8}$ ,  $\frac{1}{16}$ ,  $\frac{1}{16}$ ,  $\frac{1}{16}$ ,  $\frac{1}{16}$ ,  $\frac{1}{16}$ . The largest was attached to the side of the aquarium a little above the bottom; the others were in the mud.

On March 22, 1907, the mussels were put on a floating tray, the bottom of which was made of wire gauze. They were about 1 inch below the surface.

On May 28, 1907, two were dead; they measured  $1\frac{5}{8}$  and  $1\frac{7}{8}$  inch; they were apparently choked with algal growth.

The remainder were measured and opened on June 11, 1907. They measured  $\frac{3}{8}$ ,  $\frac{3}{8}$ ,  $1\frac{7}{8}$ ,  $1\frac{7}{8}$ ,  $\frac{1}{2}$ ,  $1\frac{9}{8}$  inch. The largest was a male, and the reproductive organs appeared to be ripening.

In about two years' time, then, the greatest growth of the lot had been an addition of  $\frac{3}{8}$  inch to the original size of  $1\frac{3}{8}$  inch, while the least increase had been only  $\frac{1}{8}$  inch.

B.—They measured on July 4, 1905, 1 inch in length.

AUGUST 5, 1906.—The mussels were examined and the following were the respective lengths:— $1\frac{1}{8}$ ,  $1\frac{1}{8}$ ,  $1\frac{3}{8}$ ,  $1\frac{3}{8}$ ,  $1\frac{3}{8}$ ,  $1\frac{1}{4}$ ,  $1\frac{1}{4}$ ,  $1\frac{1}{4}$ ,  $1\frac{1}{4}$ ,  $1\frac{1}{4}$ ,  $1\frac{5}{8}$ ,  $1\frac{5}{8}$  inch. A dead shell measured 1 inch. Some of them were buried in the mud at the bottom. Others were up on the sides of the box. It was possible to detect the increase in the shell in two of them; it was in part of a yellow colour.

On Feby. 25, 1907, the measurements were— $1\frac{1}{8}$ ,  $1\frac{3}{8}$ ,  $1\frac{3}{8}$ ,  $1\frac{1}{4}$ ,  $1\frac{1}{4}$ ,  $1\frac{1}{4}$ ,  $1\frac{1}{4}$ ,  $1\frac{5}{8}$ ,  $1\frac{5}{8}$ ,  $1\frac{5}{8}$ ,  $1\frac{5}{8}$ ,  $1\frac{3}{8}$ ,  $1\frac{3}{8}$  inch.

On March 23, 1907, the mussels were divided into two lots: 6 were put on a floating tray in which they were covered by about 1 inch of water; 6 were left among the mud on the bottom of the aquarium in which the tray floated. There was a depth of 7 inches of water in the aquarium.

APRIL 13, 1907.—The mussels on the tray had anchored themselves. One had cast off its byssus and had moved away a bit. Those on the bottom are beginning to move about through the mud which is fairly deep.

JUNE 11, 1907.—Those on the tray were— $1\frac{3}{8}$ , ♂, ripe;  $1\frac{1}{4}$ , ♀, ripe;  $1\frac{1}{4}$ , ♀, ripe;  $1\frac{1}{4}$ , ♀, ripe;  $1\frac{5}{8}$ , ♀, ripe;  $1\frac{3}{8}$ , ♀, ripe. The mussels in the mud measured— $1\frac{3}{8}$ , ♀, ripe;  $1\frac{3}{8}$ , ♂, ripe;  $1\frac{1}{4}$ , ♀, ripe;  $1\frac{5}{8}$ , ♀, ripe;  $1\frac{5}{8}$ , ♂, ripe;  $1\frac{3}{8}$ , ♂, ripe.

In two years the largest survivor had only added  $\frac{3}{8}$  inch to its length, while one had only grown  $\frac{1}{8}$  inch. They were, however, ripe.

C.—They were originally  $1\frac{1}{2}$  inch long, July 4, 1905.

On March 8, 1906, they were measured, and the following sizes were obtained:— $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $1\frac{1}{2}$ ,  $1\frac{9}{8}$ ,  $1\frac{9}{8}$ .

On August 5, 1906, they measured  $1\frac{1}{2}$ ,  $1\frac{9}{8}$ ,  $1\frac{9}{8}$ ,  $1\frac{9}{8}$ ,  $1\frac{9}{8}$ ,  $1\frac{11}{8}$ ,  $1\frac{11}{8}$ . They all show evidence on their shells of having grown.

On September 9, 1906, one taken out dead measured  $1\frac{1}{2}$  inch. The mussels seem to mass themselves at the bottom of the aquarium, on the side next the window; this appears to be the darkest corner in the glass vessel.

On Feby. 25, 1907, they measured  $1\frac{9}{8}$ ,  $1\frac{5}{8}$ ,  $1\frac{5}{8}$ ,  $1\frac{5}{8}$ ,  $1\frac{3}{4}$ ,  $1\frac{13}{8}$  inch.

They were, on March 22, 1907, put into a tray which had a bottom made of wire netting; it floated in a tank. The mussels were submerged about 3 to 4 inches.

On June 11, 1907, on examination the following particulars were found:— $1\frac{9}{8}$ , ♂, ripe;  $1\frac{9}{8}$ , ♂, nearly ripe;  $1\frac{5}{8}$ , ♂, ripe;  $1\frac{5}{8}$ , ♀, ripe;  $1\frac{11}{8}$ , ♀, ripe;  $1\frac{3}{4}$  inch, ♂, ripe. They were all well-conditioned.

The maximum growth in two years had been only  $\frac{1}{4}$  inch, while the least growth had been only  $1\frac{1}{8}$  inch.



D.—Some old mussels which had been living in an exposed situation were obtained from St. Andrews on April 4, 1905. The shells were thick, rough, dirty-coloured, and of a slatish hue. Some that were opened were found to contain poorly-conditioned animals. According to Fullarton, such mussels are called "Crocks" at Montrose; Scott and Baxter say that they are in Lancashire known as "Blue-nebs." Several of these, measuring  $2\frac{1}{2}$  inches long, were separated; they were kept in an aquarium or box with a current of water steadily flowing through it.

On April 6, one spawned; a small pinkish mass was seen lying near it on the bottom of the box. The eggs lay there till April 12. They were then examined and found to be decomposing; they were evidently not fertilized.

MARCH 8, 1906.—One of the mussels was dead.

MAY, 1906.—Another that was dead was measured and found to be  $2\frac{1}{2}$  inches in length.

AUGUST 5, 1906.—Two more dead shells measured each  $2\frac{1}{2}$  inches in length. Two remain alive; they measure  $2\frac{1}{2}$  and  $2\frac{1}{8}$  inches.

SEPTEMBER 6, 1906.—One of the mussels has moved about on the bottom of the box and left a track of byssi (see pp. 242 and 348).

FEBRUARY 26, 1907.—The mussels measure  $2\frac{1}{2}$  and  $2\frac{1}{8}$  inches.

MARCH 22, 1907.—The mussels were put on to a floating tray, in which they were submerged about 1 inch.

APRIL 13, 1907.—The mussels have made quite a heap of muddy excreta below them on the bottom of the box. One had its round end sticking up out of the water, and it remained thus for eight days, when it sank again.

JUNE 11, 1907.—They measured (1)  $2\frac{1}{2}$  inches, a male; it had a thin mantle, and was getting ripe; (2)  $2\frac{1}{8}$  inches, rather thin mantle, was getting ripe.

In two years one has grown  $\frac{1}{8}$  inch; the other has not increased in size.

Taken all over, the flesh of these mussels (A, B, C, and D) was in average condition of fatness. Their shells, however, are characteristically shaped. They are rounder, of greater thickness from side to side, but not so high as more rapidly growing mussels. In figs. 26 and 27 are shown two views of one of these mussels, and in figs. 31 and 32 two views of one of the mussels of the same length, but which had grown on a screen in the large pond.

#### *Conditions Favourable and Unfavourable to Growth.*

The rate of growth of the mussel depends on a number of factors which may be briefly summarised as—(1) the quantity of food, (2) salinity of the water, (3) presence and quantity of mud, sand, and filamentous algæ, (4) length of exposure to the air during each tide.

SPATTING.—As a rule mussels spat readily, and in large quantity; the scarcity of mussels in a locality is not usually due to a deficiency of young. The young may not have a suitable area upon which to settle; they may settle too high up, and in consequence be uncovered for too long a period each tide. They may settle on a high scarp and swamp it, and the increased competition for food that results will militate against the growth of the individuals.

In July and August the surface of St. Andrews Bay, according to M'Intosh, swarmed with minute mussels of a somewhat circular outline. The same author states that they appear in the zoophytes in

July, like grains of millet seed, measuring from  $\frac{1}{4}$  to  $\frac{3}{4}$  inch in length. Young mussels have been noticed on the ropes of the salmon nets about the middle of June.

The young mussels seem to settle high up in greater profusion than in the deep. On a wharf the upper limit of the mussels was between tide-marks, but several feet below high-water mark. Barnacles (*Balanus*) settle high up. A curious circumstance was noted with respect to the attachment of barnacles (*Balanus*) in a slate tank. The inflowing water was taken down to the bottom of the tank by means of a rubber pipe. The water leaving the mouth of this pipe impinged at once on one of the sides, and here an area of about 6 by 2 inches was covered by barnacles, but nowhere else on the tank, which was 5ft. by 2ft. 6ins. broad, was any barnacles attached. It would seem as if the impinging against the hard surface helped the barnacle to become attached.

Wilson found on the ropes of the salmon nets mussels measuring from  $\frac{1}{8}$  to  $\frac{3}{8}$  inch in length. The largest were got near the surface, and the smallest near the bottom. They were at most five months old. M'Intosh observed mussels up to  $\frac{3}{8}$  inch in length on the buoys of the salmon nets; the buoys are in the water from February to the end of August.

At Montrose, Fullarton and Scott say that the bulk of the spat is carried out to sea by the quickly-running tide. Dredging the navigable channel destroyed seed and prevented it settling.

In the experiment of laying down mussels in Coquet, Meek found that the mussels grew there to a good bait size and were well filled. The unfavourable circumstances in that locality were (1) the mud which comes down the river during a fresh flow, and (2) the dredging of the harbour, which would interfere with the lodgment of spat. M'Intosh, however, observed in the Tees "that immediately (100 yards) behind the dredger, and directly in its track, young mussels from  $\frac{1}{2}$  inch to  $\frac{1}{4}$  inch long, with dull yellowish or pale olive valves, occurred on 11th June. These small examples attach themselves to fragments of stone broken by the dredger, or to stratified clay, so that the fresh surface left after the operations of the steam dredger is soon covered with mussels."

**THE MUSSEL BED.**—According to Calderwood—"The mussel will grow on almost any natural sea or estuarine bottom, but the rich flats where sand and gravel are covered by mud charged with diatoms, infusoria, spores of algae, and other vegetable matter rear, large fat mussels most quickly. . . . Mussels grow well in some places where they are covered at low water by 10 to 15 feet of water, and in the beds of estuaries where they are never uncovered. . . . The favourite position of the mussel may be said to be between the low-levels of spring and neap tides. . . . In Holland the Government beds are usually laid down where the water has a depth of from 7 to 15 feet at low tide. The mussels grow commonly to a length of 2 or 2½ inches. They are, therefore, of excellent quality. . . . Beds should be protected as far as possible from the deposition of silt. This evil, if present, can only be remedied by transplanting the mussels from the high bed, and causing the available currents to scour and wash down the deposit."

The Budle Bay mussel is, Mr. King states, much broader than the Boston mussel, which is inclined to be round and plump.

According to Lebour, "the mud and sand brought down by floods and currents during storms are hurtful, as they frequently choke up and kill large patches of mussels." In the river Blyth many of the mussels are "burrowing in the mud generally so deep that only the smallest part of posterior end of the shell is visible." In the river Aln "many of the

mussels are very small and thin, too small and thin to be of any value for bait. Although all the specimens examined in October and November were quite thin, in the Spring the reproductive lobes were spreading into the mantle to a small extent, so that they probably still shed some spat."

I received some information from the Elginshire deputation of fishermen regarding the mussels near Dingwall and at Findhorn. At the former locality mussels about two inches in length were to be obtained in September, but by next Spring nothing remained of them but empty shells. The fishermen said that they filled up with sand.

In the Findhorn, according to Mr. Masson, mussels taken out of the deep in September and put into shallow water open up to the warm sun and die. Calderwood mentions that "seed taken from deep-water beds will not admit of being carried so well as seed which is inured to exposure from being left bare by the tide."

Gregg Wilson, in his report on the mussel beds of Northumberland, recommended that, "where there are not at present mussels, but where there is shelter from storms, freedom from shifting sand and mud, a fairly hard bottom, and a good current of water, mussels might be laid down by way of experiment."

Mr Wm. M'Bride, jur., Pirnmill, Arran, who was one of the deputation of Buteshire fishermen attending the demonstrations in 1906, informed me that the mussels on the wharves grew the fastest in that locality. According to M'Intosh, "the fishermen regard the mussels got on the piles of the bridge the finest examples. (River Esk, England.)"

At Kiel the mussels, according to Möbius u. Meyer, are cultivated on branches of trees that are stuck into the bottom below low-water mark.

The salinity of the water exerts an influence on the size of the mussels. Brandt says in this connection that in Kielbight the mussel grows to a size of 110mm. ( $4\frac{1}{2}$  inches), but in the Gulf of Bothnia, where the salinity of the water is less, the mussel only reaches a size of about one inch. Moreover, the shell of the Baltic mussel is thinner and lighter than the North Sea mussel, notwithstanding the fact that the water of the Baltic has the larger proportion of lime in it. In the Kaiser Wilhelm Canal Brandt found that the salinity of the water decreased as one proceeded along it, from east to west. Ripe mussels were found of a smaller size in the fresher parts, viz., at 17-22mm. in length ( $\frac{3}{4}$ - $\frac{7}{8}$ -inch), than in the saltier portion of the canal, where the smallest were from 35 to 40mm. ( $1\frac{1}{2}$ - $1\frac{3}{4}$ -inch) in length.

**THE AGE OF THE MUSSEL.**—"A size suitable for bait, viz., 2 inches in length, would be about two years old in a favourable locality. In less favourable localities, where the mussels are left long dry, the time taken to reach the size indicated appears to vary from 4 to 8 or 10 years" (Calderwood).

In the Wash, according to Donnison, "a 2 years old mussel on a high scalp is probably not  $1\frac{1}{2}$  inches in length, but on low ground the length is probably 3 inches."

Two lots of mussels were obtained from St. Andrews. The first lot, which was estimated to be composed of two-years-old mussels, measured from  $1\frac{1}{2}$  to 2 inches, shown in natural size in figs. 1 and 2. The other lot, consisting of three-years-old mussels, varied in length from 2 to  $2\frac{1}{2}$  inches (figs. 4 and 5).

In Northumberland Lebour states that a mussel 2 inches long and about  $\frac{3}{4}$ -inch in thickness is considered a fair bait. "The mussels," at Budle Bay, "are from a year and a half to two years old when they are lifted and planted in the stream channels, where they are covered for six or seven hours each tide, or even not uncovered at all, as these last are

perhaps the best. They reach bait size quickly, and are esnerally allowed to fatten for a year, so that at four years they are ready to be sold for bait or food, but are often kept until they are 5 or 6 years old." The Budle Bay mussel is an excellent bait at 3 years of age (King).

TRANSPLANTING.—In the Eden, Wilson says, the scaups are mostly found on muddy flats, uncovered at low water. They are cropped in rotation. The "seed" consisting of young mussels from  $\frac{1}{2}$ -inch to one inch or thereabouts in length, are dredged from parts where they have been deposited naturally. These have in many cases previously carried a crop of mussels. The seed may, however, grow on places unadapted for rearing saleable mussels. The rate of growth is very rapid, an inch to an inch and a half in a year being no uncommon addition to the length. It seems to be the case that the longer the mussels are dry between tides the slower is their growth. The quickest growth is made by those lying in the bed of the stream, where they are never uncovered; the higher the scaup the less chance of success. Some hurdles erected for Professor M'Intosh in the Eden became densely covered with young mussels. Mussels are commonly dredged in the Eden  $4\frac{1}{2}$  inches in length.

According to Fullarton and Scott, "the bed of the river is a fruitful source of seed at Montrose. Sometimes seed has been obtained by taking quantities off the foreshore rocks. When the seed attains a suitable size,  $\frac{1}{2}$ - $\frac{3}{4}$ -inch, about the size of an ordinary bean, it is dragged from its bed by means of rakes into the cobbles. If the mussels are left long on a high bank they become stunted in appearance, and additions take place to the shell in thickness rather than in length, the consequence being that the mussel assumes an inelegant shape and a blunted aspect at the posterior end, and instead of a brownish-black layer of periostracum on the outside of the shell, a greyish coating there indicates the dwarfing of the mussel. These mussels are locally known as 'crocks.' When they are transferred to lower banks, and banks more within reach of the tide, they soon begin to grow, and the capacity of the contained space becomes enlarged. It is found that the time required for the seed to mature and reach the bait size varies from three to eight years. On one of the best banks it may grow to two inches or larger in three years or so, but on most of the banks a much larger time is required. Severe winters retard the growth of the mussel."

On Budle Bay, Northumberland, King had some of the dwarf mussels found on the rocks near the shore transplanted; they were all failures. He says that a mussel requires a twelve months' growth before it will stand transplanting.

Meek writes that at Montrose seed mussels, 2 to 3 years old, are lifted from the channel and deposited on the bank, where they remain from 2 to 5 years more before they attain a saleable size. "In the Eden the seed is taken from the higher and shoreward parts of the banks at 2 to 3 years old, and removed to suitable places near the channel, where it requires  $2\frac{1}{2}$  to 3 years before it reaches bait size."

Scott and Baxter describe transplanting operations which they carried out at Morecambe. The mussels, which were small through overcrowding, were removed to lower ground where they were practically always under water, being only exposed for a short time at very low ebbs. "Many of these mussels were what are locally known as 'blue-nebs'—very old mussels with thick shells of a dead-blue colour, much corroded, especially in the hinge region, and having no epidermis on them. When the shell is opened the animal is usually found to be thin and watery. These mussels are commonly met with on the sea-shore. They are exposed to the air for a long time between each period of high-water and are beyond

the reach of a continuous supply of food. They may justly be regarded as mussels that have ceased growing and are only existing." At the end of five months they had grown  $\frac{3}{8}$ -inch, and instead of being thin and watery, they were in fine condition. Six months after transplanting some mussels that originally measured  $1\frac{1}{2}$ -inch were found to have added  $\frac{3}{4}$ -inch to their length, while the mussels that had been left in the original bed had increased  $\frac{1}{4}$ -inch in the same period. The authors drew attention to the fact that it is comparatively easy to detect a mussel that has been transplanted. The new part of the shell is black and clean, in contradistinction to the slatey-coloured originally stunted shell. *Vide* fig. 105, which is a drawing of a transplanted mussel from St. Andrews, natural size. A-B represents the original seed; B-C increase in the shell after transplanting.

The mussel that grows to a full size in the deep without transplanting has a uniform shell, darker and cleaner. The barnacles (*Balanus*) do not settle on mussels in the deep to any considerable extent.

THE MUSSELS IN THE LABORATORY AND POND.—None of the mussels in the Laboratory grow to any extent. They were supplied through the upper reservoir from the inlet pipe of the big pond. In the pond a large quantity of mixed mussels were got. They were attached in a broad row on the side of the pond about a foot from the bottom, and three feet below the surface of the water at one part, and six feet below it at another.

They were most thickly packed near the inlet of the pond, and extended along one side, across the end, becoming gradually fewer. Practically none were found on the third side. It is remarkable that they were not spread all over the pond. The barnacles (*Balanus*) were spread all over the sides right up to the surface of the water.

The row of mussels coincided with the line that the current flowing into the tank takes. A wire-netting screen inside the tank intercepted the current to some extent, and the mussels attached themselves to it in quantity. On one occasion when the screen was removed the greater part was choked with a sheet of mussels. The mussels in the pond were of all sizes up to  $2\frac{3}{8}$  inches and they were fat. Some baskets of them were tried as bait by the local fishermen, and they were found to do just as well as the mussels they were using.

Mussels were found in the upper reservoir tank up to a size of  $1\frac{1}{2}$ -inch, and when examined in November they showed thin, ill-conditioned animals. This seems to indicate that the water-supply was poor in suitable food, generally so for part of the year.

The pond itself would probably breed its own supply of diatoms and other food, and that may account for the fatness of the mussels there.

The water supplied to the Laboratory contained, no doubt, at certain times of the year a good supply of suitable food, but probably on the whole the quantity of food was not abundant. That will account in some measure for the fact that the mussels grew so little. But there were other mechanical drawbacks. The vessels in which the mussels were kept soon had a deposit of fine mud on the bottom. This was in part excreta; the mussel took in the fine mud that entered in suspension in the water supply, and which, if not arrested by the mussel, would have largely passed out by the overflow, and excreted it in a compact ribbon form. It was now much heavier, and lay on the bottom close to the mussel. This would tend to arrest fine mud.

When the mud accumulated to the depth of possibly half-an-inch, the mussel sometimes moved about to free itself from it. It might simply shift its position on the bottom, showing its movement by the track it left in the mud, or it might climb up the side of the vessel.

Some mussels taken off the wall of the big pond were put into a fish-box, which was sunk to the bottom near the inlet valve. The bunches of mussels were clean when they were put in. In the Spring (April), after having been in the pond since the previous November, that is, for a period of five months, the box was examined. The mussels were now found to be embedded in a thick bed of slimy adhesive mud. The bottom of the pond had comparatively little mud on it at that part. The mussels had gradually collected the mud from the water that passed through the box, and when they passed it out in the form of excreta it had been retained there. In the bottom of the mud some of the mussels had been choked, the empty shells alone remaining. These had been bound by the other mussels in the bunch, and had not been able to free themselves. Other individuals had grown.

Some bunches of these mussels were washed and put into a floating box, in which the mussels were submerged about six inches, and were three to four feet above the bottom of the pond. On July 19, when they were examined, they were found to have collected a fine greasy coherent mud in a corner of the box where there was no opening in the bottom to permit of the excreted mud escaping, as it could do in other parts of the box. This indicates their capacity for collecting mud. The box was floating in a part of the pond which was shaded by the floor of the tank house. The mussels were judged by an authority to be of good quality. The surface of the box was thickly coated with barnacles (*Balanus*), especially on the side facing the inlet of the pond.

In addition to the accumulation of mud, the mussels in the aquaria in the Laboratory suffered under another unfavourable condition. Being exposed to the light, they were in the summer months coated more or less with a growth of filamentous algæ, which also lined the interior of the aquarium. This prevented them feeding to their full extent. Fig. 56 shows a mussel fully opened.

The mussels were in the quality of their soft parts in good condition generally, but they had not grown. The majority had survived. The permanent conditions, salinity of the water, and quantity of food were suitable; the latter was possibly not specially favourable. The local and temporary condition, viz., accumulation of mud and algoid growth, were unfavourable. They were never left dry, so that they had not this recognised interference with growth to contend with. The mussels were put into floating trays to escape the mud, but this arrangement intensified, if anything, the growth of the algæ, in that way neutralising the advantage accruing from the freedom from mud.

A sufficiently strong current running over the mussels, or a current interrupted and reversed, such as is afforded by the tide, might have prevented the accumulation of the mud. It would also appear to be an advantage that the mussels be kept away from a strong light, by being well submerged, where these growths would not develop.

FEEDING.—When the apertures of a mussel are wide open (fig. 56), a large quantity of water is taken in, and the water issuing by the anal siphon forms a very considerable current, as has been noticed when the mussel was near the surface.

When a mussel is surrounded by a thick layer of mud, or with filamentous algæ, it does not open its inhalent aperture freely, and therefore cannot obtain a full supply of food. Even although there is a considerable quantity of mud in suspension in the water, that does not seem to prevent the mussel opening its inhalent aperture to the fullest extent. Diatoms, foraminifera, and spores have been found in the mud in the aquaria.

The mussel sometimes rests a long time with the valves of its shell practically closed, even in clear water.

I made some experiments on the behaviour of the mussel when exposed to very muddy water. A mussel was left in clear running water until it opened its apertures fully. A quantity of muddy water was then poured out close to its siphons from a pipette. The fine mud entered by the inhalent aperture, and immediately thereafter the mussel shut the frill of that part, and sometimes its exhalent siphon and its valves. It then began at once to expel the mud from its branchial chamber by the upper part of its inhalent aperture, the lower part of the same being meantime shut by means of the frills. The mud came out mixed with mucous in the form of small balls sometimes. No mud is allowed to remain in the branchial or mantle chamber of a healthy mussel. The mud, if it enters in suspension, passes on into the gut; if in quantity it is excreted without getting to the mouth. It is, therefore, apparent that an excess of mud is not of advantage to mussels.

A situation where the mussels could get diatoms and other microscopic forms, larvæ, etc., with as little mud as possible, should be most favourable for growth. It is possible that they might grow well suspended above a sandy bottom. The young attach themselves to wrecks and other objects lying on a sandy beach.

King thinks that there is more food for the mussel in brackish water than in sea-water, and that the brackish water promotes more rapid growth than sea-water. "Nevertheless, where there is any kind of shelter and freedom from travelling sand, mussels do very well in their native element. A little sand or mud is not of great consequence. The mussels are able when in a body to raise themselves up through it, the more so when a running stream is passing over them."

**THE EXCRETA.**—The excreta take the form of a narrow ribbon (fig. 98); it is very often discharged in small pieces, but on one occasion it was seen projecting from the exhalent siphon as a band 4 inches in length. In section it is arched, *vide* fig. 97.

In a box in which there was only a thin layer of mud, the mussel each day had a little heap of excreta lying near its round end. The water flowing through the box was not muddy to the eye. In the ribbon were found the remains of diatoms; but it consisted mainly of mud.

**SENSITIVENESS TO SHOCK.**—It was noticed on several occasions that on approaching a vessel in which there was a mussel with its inhalent aperture widely open, it would suddenly shut, and close its valves partly; after a little it would shortly open out again.

#### *Difference in Colour of Mantle, and Fringe, and Siphon.*

In two mussels which spawned in June, the fringe of the mantle was darker in colour than in some of the other mussels near them.

One large mussel, a male, had the inhalent siphon and the frill of the inhalent a very dark purple colour (fig. 47).

In another, the inhalent siphon was dark at its base, and had a white distal part; the frill of the inhalent had a dark amber base with a lighter amber colour on the free border (fig. 40). Another, which had principally an amber colour in these parts, had the whole of the anal siphon dark.

The frills are sometimes dark to the tip, sometimes distinctly lighter there. The inhalent siphons are sometimes tipped with white or wholly white, amber, or purple.

Some shelled mussels were examined in order to see if the difference in colouring was sexual. But no definite rule was made out.

*The Movement of the Mussel.*

In its larval stage the mussel floats about subject to the drift of the water, and possessing an independent motion from its own cilia.

When it sinks to the bottom, it travels about over seaweeds and stones, by means of its long foot, which is ciliated. It extends its foot, takes a hold with the tip, and draws its body up to that position. It does this actively and moves at a fair rate.

It has also the power of attaching itself by means of its byssus. M'Intosh informs us that these young mussels, when attached to zoophytes, "can detach themselves at will, and if the water in which they are confined be impure, they become restless, and soon, forsaking the zoophyte, swim to the side of the vessel, where they swarm at the water line. In some cases they have been noticed to migrate merely from the lower portion of the zoophyte to the upper branches, near the surface of the water." They measure about  $\frac{1}{10}$  to  $\frac{1}{8}$ -inch. Towards the end of September many minute mussels,  $\frac{1}{8}$  inch long, are found on the bases of the zoophytes.

This power of moving by means of its foot and of detaching itself the mussel retains during its whole life. As a rule, active continued movement of the mussel in a line is only noticed in the earliest bottom stages.

Some mussels about  $1\frac{1}{2}$  inch in length, when put on August 5 into an aquarium, became fairly active. They can move themselves along sharp end first, leaving a trail like a snail track; it is narrow, as is the foot when extended. The mussel does not need to form byssus threads when it travels on the level, at this size at least. It can draw itself round by putting out its foot at right angles to its long axis and slewing its sharp end. None were seen to go round end first. One had its foot straight out in front of the round end, but no actual movement was detected before the foot was withdrawn. Big mussels do, I think, move round end first.

All mussels are anchored by means of the threads which they form with the foot, and they may be held fast by the threads of another, or of several mussels. If they wish to shift their quarters in consequence of unfavourable conditions, as, for example, the risk of becoming choked with mud, the mussel may, without difficulty, do so if it is not bound by other mussels. In the latter case, it may have to stay and be destroyed.

When the mussel is not bound by other mussels, it may break its attachment in several ways. It must first find a solid object to which the tip of its foot may firmly adhere. Then by shortening its foot it throws a strain on to the byssus. That strain may result in snapping the threads, or some of them, upon which the strain bears, and the mussel may be able to move a little away while the remaining threads still hold fast. The mussel may then make new threads to stay it on either side in its new position. The movement may have been made in any direction, end on or sideways. From the new position it may drag itself along in another direction, snapping some more of the threads that detain it. The discs of some of the threads may become detached from the stone to which they were adhering when the strain was put on them. On an old byssus many threads are found loose and bearing their discs. Finally the mussel may cast off the whole byssus, when the byssus is too strongly attached to break, by tearing it out by its root. So far as my observations have shown, the mussel after this happens does not go very far before it spins itself new byssus threads. In fact, it would appear simply to make the one step, and then attach itself by one or several threads put out anteriorly, posteriorly, and across (*vide* fig. 67).

Two mussels were kept in a box in which the mud accumulated. One of the mussels was observed after some months to have been shifting its



place, leaving a track in the mud. When the box was cleaned a track of byssi on the bottom was seen, showing the stages of its progression. This track is reproduced in fig. 67. Nos. 1-11 indicate successive positions of the mussel in its journey over the bottom of the box. The track is reproduced about natural size; the mussel is shown in natural size in fig. 69. The same two mussels were put into a glass aquarium, and a track was also found on the bottom of it. This is shown in fig. 68. The mussel had evidently proceeded by little, fairly regular stages. The length of its stay at a place is indicated by the number of byssus threads there. The shorter the stay the fewer the threads. In some positions it has apparently only formed one thread, and then given it up to shift another stage.

• I have noticed a mussel move itself by minute jerks within the limits of movement permitted by the attached byssus threads. It is, of course, able by means of the muscles of its byssus to throw a strain on or slacken the byssus threads, independently of any pull which it may be making with its adhering foot.

The mussel may remain months without shifting out of the spot. Its track is sometimes in a circle, coming back to cross itself.

Lang mentions that the mussel is able to climb up a perpendicular wall by lifting itself by the foot and then making a thread fast.

The thread may be made while the foot is in any condition of extension or contraction; the length of the thread and its character various with that condition. From the position thus secured, and suspended by the thread now drawn tight by the byssus muscles, a further or a side position may be got for other threads. From this situation it may then climb a further stage.

A mussel formed a thread, that is, withdrew its foot and exposed a new thread, at 2 o'clock. At 2.23 it was noticed that the foot had been again extruded. By 2.25 a new thread was exposed. It had taken less than 25 minutes to make the thread.

The movement of the mussel was observed in different boxes in which mud accumulated, and it was also noticed in some mussels that were on a floating tray. The latter were covered in part with filamentous algae.

Figs. 70-80 represent periodic drawings of a mussel and its byssus threads from the time it was put into a clean aquarium by itself. The faeces was kept clear of it by being removed each day for the first month or so. During the first night it had put its foot out in every direction, and had cleared away the thin layer of mud, leaving an impress of the positions that its foot had taken up. It had made only three threads.

Its changes in position were watched from April till July; during this time it shifted its position slightly now and then. It began to move in the beginning of May; at the end of the month the excreta had accumulated near the inhalent aperture and the mussel had slewed round to the right to a position at right angles to its original one. The following day it had gone back to the left.

On June 18 the mussel was now enveloped in a growth of algae, and it had turned right round in the same spot, after breaking some of the threads. On July 4 it occupied the position shown in fig. 80. It has moved away a little, having thrown off two byssi that represent temporary positions. On July 11 some algoid filaments were attached to the shell near the edge, and the inhalent aperture was only opened a little. The shells were separated, but the aperture was closed by the frills. It had broken free and moved off a little way by July 13. On July 15 it was over to the right, having made two small byssi tracks, and on the following day it was found over to the left. Its shells were hardly open;

the algae were tending to retain the faeces in close proximity to the mussel.

Several of the mussels, though set originally on the bottom, climbed up the sides.

Mussels, if placed on their back in water, very soon turn back up, usually within 24 hours. Some mussels,  $2\frac{1}{4}$  inches long, were put on the bottom of a box filled with water, with the hinge down. Certain of them showed some activity in turning back up; they had done so by next day. They put out the foot, round the shell and down to the bottom of the box, and, taking hold with the tip of the foot, they pull themselves round till they lie back up. One moved a good bit out of the run of the current which ran over the bottom of the box. Others attached themselves where they happened to have been set down. On July 12 one in a glass aquarium had not yet succeeded in turning over. It attached some threads to its own shell, and a few days later some threads were fastened to the bottom. A day or two after it was seen to be back up. It had been back down for nine days.

Some mussels were put into a box, and 18 hours afterwards they were all attached by byssus threads. Another rose up on end and attached itself with a large number of threads in the same time (fig. 81).

*Mussels Trying to Keep in the Water by Slackening the Byssus.*—Some small mussels, about  $1\frac{1}{4}$  inches long, were attached up on the side of a box filled with water. When the water was being let out the mussels, as they were being left by the water, slackened their byssi (fig. 82) in order to keep themselves in the water; but when, having come to the end of their tether, they found the water still receding, they hauled in again and lifted themselves up tight against the side of the box (fig. 83)

*Movement of the Modiolus modiolus.*—On March 22 some *Modiolus* were put into a tank. They were very slow in attaching themselves. By April 4th one of them had attached itself by some very long threads, had cast its byssus and re-attached itself. Later, there were several of these cast byssi, some of them having only a few hairs. The *Modiolus* therefore appears to behave exactly similarly in the matter of movement to the *Mytilus edulis*. It does not appear to be so active, however.

#### *The Anatomy of the Byssus and Foot.*

The most important publication on the subject of the byssus with which I am acquainted is Tullberg's. He gives drawings of sections of the byssus-pit and foot, and also of the septa of the pit and various glandular elements. From Tullberg's extracts it is clear that Müller's theory regarding the mode of formation of the byssus is wrong, in parts at least, as Tullberg maintains. I have not been able to consult Reichel's paper, "Ueber die Bildung des Byssus der Lamellibranchiaten, *Zool. Beiträge, Schneider*. 2 Bd., 1888."

Lang summarises the description thus:—"The byssus can generally be thrown off or replaced by a new one, and many forms can move about on a smooth perpendicular pane of glass by means of alternate attachment and rejection of portions of the byssus applied by means of the foot. [It is doubtful if a portion of the byssus can be rejected, unless merely the snapping of threads is here meant by the expression.] The byssus cavity is divided into narrow shelves by numerous folds which project from each side into its lumen. A septum descending from its roof further divides it into two lateral parts. The byssus secretion is yielded partly by the

cells of the epithelial walls, partly by the glandular cells which lie in the surrounding tissue, their ducts passing between the epithelial cells. The secretion takes the form of the cavity, and is thus held fast as with roots by the numerous lamellæ which occupy the shelves. As the amount of the secretion in the cavity increases these lamellæ are pressed into the duct, where they unite to form the main stem of the byssus. When a bivalve attaches itself it forms a byssus thread in the groove [of the foot] which fuses with the end of the main stem."

Tullberg says that the groove of the foot, the side of the byssus-pit, and the septa are clothed with cilia. These I have not been able to see. Tullberg throws doubt on Sabatier's observation that the middle vessel of the foot opened to the exterior in the depression at the end of the groove. I have been able to confirm this. Tullberg describes at length and discusses the function of the main gland-masses present in the foot. The main gland is white (yellow from outside the foot); above it there is the green (or purple) gland, and on either side of the groove a less gland somewhat similar to the latter. He says that the walls of the byssus pit as well as all their sheaths are principally formed of connective tissue, to which the muscles which surround the pit are attached. In the connective tissue, and between adjacent parts of the muscle-bundles, are found glands similar in nature to the white gland of the foot, although they are separated a little more from one another. The root of the byssus consists of a multitude of thin structureless lamellæ, one in each compartment. They can be easily split into threads. They are folded in many plaits, where the byssus pit narrows to form a neck. He divides the lamellæ into primary and secondary lamellæ. The septa in the hind part of the pit end sooner than in the other parts, and the lamellæ, according to Tullberg, are enveloped by the lamellæ from the front part of the pit, forming an outer binding rind to the byssus stem. In section this is seen to be composed of concentric rings. Each of the byssus threads is attached to one of the above-mentioned concentric layers, and appears to be formed simultaneously. I do not agree with this, as is shown below. No part of the lamellæ takes part in the formation of the thread. Tullberg says that the thread appears to consist of a quite homogeneous substance, although in sections the surface stains differently with carmine than does the internal part. But this may be due to the outer surface having been acted on by sea water, not to any difference in origin and quality. The thread splits up into fine threads, just as do the lamellæ and the stem. Müller had described seven openings from the foot-gland into the end depression. Tullberg found one only. I have observed a number of slits in the floor of the depression, but I did not make out their connection to any gland. The lamellæ grow through the flow of secretion. He says that it is possible that the secretion of the green gland may be used to coat the thread with a fine skin.

I have examined the structure of the byssus and the foot. My results are in general agreement with those of Tullberg, except in one or two points. For example, I do not agree that there is any enveloping rind to the stem such as he describes. The base of each thread forms such an envelope, and, where the threads have been made one after the other in rapid succession, a thick rind is formed by their overlapping bases. On those parts of the stem where there are no hairs attached there is no rind.

I will discuss the structure of the foot first, then the byssus-pit and finally the thread and its formation.

Foot (figs. 3, 43, 45, 60).—The foot is a brown or purple-coloured organ. It is very muscular, capable of retraction into a small body,

as is seen in a dead mussel, or extended into a long narrow band, as is the case when the animal is forming a thread or dragging itself along by means of it (fig. 43). The tip of the foot differs from the remainder of the organ. It is possessed of a sucker property by which it can take firm hold of any hard foreign object. On the under surface of the foot there is a groove (fig. 42) continuous with the byssus pit (by-p) proximally, and distally opening out into a broad heart-shaped depression (de), a little short of the extremity of the foot. The tip of the foot, that is, the part including and beyond or distal to this depression, has the power of making vermiform movements, even after the foot is cut out of the mussel. The whole of this tip, including the depression, acts as the sucker. The depression is simply a widening out of the groove, to vanish gradually distally.

The groove (fig. 42) consists of two cushion-like lips (l) and a narrow inner part, which is closed in by the cushion lips to form a tube in which the thread is moulded.

The sides of the groove and its lips are creunate and vertically laminate. When the foot is contracted the groove is a sinuous line, but the more the foot is extended the straighter the groove and the smoother the sides become.

The foot is a mass of muscles and glands. On the outside the skin is longitudinally grooved, and when contracted it is circularly grooved. The muscles of the foot enter it at its distal end and proceed right along the foot to the tip, and are inserted all along the skin of the whole of the foot on every side, in big bundles along the upper side and edges, single fibres into the glandular areas. The only part where they do not appear to reach the skin is the groove. They go to the lips of the groove. The muscles are in bundles of various size, and between the bundles there are lacunæ, which give in cross section a spongy structure, except in the glandular area.

When the under surface of the foot is examined, it is seen that a yellow-coloured band (y-g) borders the groove on either side, and is continued right round the byssus-pit (fig. 45). This is the series of glands which supply the secretion that forms the thread. There is a separate gland to supply the depression in which the button that attaches the thread to a foreign body is formed. This end gland (the purple gland) appears to be different from the other, but that is possibly due merely to it being differently set in the foot to supply this altered part of the groove.

#### *Transverse Section of the Foot. (Fig. 51.)*

In the transverse section there are shown first the groove, its cushion lips, and on either side granular areas, viz., white glands, yellow when seen from outside (y-g). The remainder of the section is taken up with muscle bundles cut across (m), the so-called green (or purple violet) glands (p-g) (fig. 55) and the vessels, of which three are prominent—a median (m-v) and two lateral (l-v).

**THE SKIN.**—The skin forms a rind of varying thickness; it is especially thick at the edge of the foot. Outside there is a thin clear layer, the cuticle (ct) present all round except in the groove (fig. 54); it is present on the lips of the same. Next that layer comes the pigment layer, which is formed of large columnar cells (cl) containing more or less pigment; they are mottled with brown or violet colouring matter. The columnar cells vary in size in different parts. Next the columnar cells there is a fairly thick layer consisting of what resembles circular muscles. On the inside of the rind come the longitudinal muscle bundles (m) that

are inserted into the skin in rows, which, when the skin is separated, show as ridges (fig. 39). The space between these ridges is occupied by glands (g).

The large white glandular area surrounding the groove on three sides is that which was indicated on the outside of the foot by the yellow band. When cut into there issued a copious, finely granular fluid that coagulates soon. The white gland is laminated in structure, although its connective tissue seems practically solid. It teases into stringy material. Muscles run longitudinally through the white gland (m, fig. 51). Next the side of the groove a part of the glandular area is distinguished from the rest by a slight difference of colour. It consists apparently largely of oblique muscular fibres with glandular tissue (m and g). The longitudinal muscles of the foot give off fibres to the glandular area. The skin at the lip of the groove is thin and is connected by fibres to the white gland.

**THE MUSCLES.**—Between the large glands and the skin are the longitudinal muscle bundles, inserted into the skin and giving off fibres to the glandular parts. There are also oblique muscles on either side of the lip of the groove (m and g). Associated with them can be seen some violet pigment.

The longitudinal muscles consist of two main median muscles and a lateral on either side. Large lacunæ are to be seen opening between the muscle bundles. There are glands associated with the muscle bundles and fibres.

**THE VESSELS.**—The median vessel occupies a position between the two median groups of muscles, and is flanked also by the so-called green glands. This vessel opens to the depression at the end of the groove, as Sabatier maintained. It continues past the opening for a little distance into the tip of the foot. Each lateral vessel is associated with a lateral muscle.

**GREEN OR PURPLE GLAND.**—The green (or purple) gland is situated above the main glandular area. There are muscles in this gland. An apparent vessel which was noted by Tullberg was also seen. It was dark violet in colour, and showed its centre a deep violet. The muscles of the gland are inserted in sheaths into the lower surface of the foot beyond the white glands. This gland is much bigger than the white gland near the end depression of the groove. The glandular tissue next the gland is mottled lightly violet, and the muscle fibres have a slight violet tinge. Fig. 55 shows an element of the purple gland.

**THE GROOVE.**—I found no cilia in the groove. In the section I saw a hair sticking out from the side, but it appeared to be merely a thread of the secretion, which had taken the shape of the opening of the duct from which it issued. The secreting region in section shows a mass of little tubes (secs, fig. 55). The cushion lips show an outside cuticle.

#### *Longitudinal Section.*

In longitudinal section it is seen that the muscles gradually taper from the proximal part to the distal; that is due to the fibres being gradually inserted into the skin.

The white gland is seen to be smaller in the proximal part than distally.

#### *The Byssus Pit.*

The byssus issues from the proximal extremity of the groove in the foot. If the byssus pit and the foot be dissected away from the remainder of the mussel the relationship of the parts is more readily seen. (Figs. 45 and 60.)

The neck of the pit grips the stem of the byssus tightly; it is formed by the continuation of the side of the groove of the foot. The neck has a soft collar which is everted when a strong pull is made on the byssus, and which is smooth on its inner surface (i-c and i'c, fig. 46).

**MUSCLES.**—The byssus pit is supplied with two sets of muscles, one set arising near the hinge from the surface of each half-shell. If the two sets of muscles be torn apart, and the separation assisted by a knife, the pit will be split into halves, and so will the byssus stem; the pit is bilaterally symmetrical (fig. 63). One group of muscles occupies a position where it gives off fibres to the outside of both halves of the pit. Between the muscles are crowded large masses of yellow glands (g, fig. 23).

The foot and the byssus pit are not strongly bound together, the only connecting part being the neck of the pit. The neck does not belong to the pit; it belongs to the foot. The relation of the pit and the foot is expressed thus—that the byssus stem passes through the groove of the foot at its proximal closed end (fig. 42).

**SEPTA.**—The pit itself is roughly pear-shaped, the byssus-stem forming the stalk (fig. 37). It is divided vertically by thin septa into a great number of slit-like loculi, set parallel with the median vertical longitudinal plane of the mussel. The septa are flat in their greater extent, but inferiorly they are curved in a slight spiral as they go to join the byssus stem. This condition is shown diagrammatically in fig. 95. When the pit is split into two as above, some of the septa are cut across. Each muscle is inserted across all the septa in its own half of the pit; i.e., each septum gets some strands of each muscle.

A septum was dissected off (fig. 34). It is striated in texture, and is transversely ridged. The ridges are mostly developed on the lower half; towards the upper limit they disappear. Some of the fibres of the muscle on the outside of the pit come away with the septum; they are straight and have glands attached to them (g). The septum is attached firmly to the binding tissue uniting the insertions of the muscles. At one part of the outside of the pit the edges of the septa are free. The septum shows a tendency to split along a line between the insertion of two groups of muscles. In the upper narrow part of the septum the ridges crossing obliquely are in connection with the muscles inserted on one side.

In preserved specimens, killed in formalin, the ridges are very prominent, the septum being thrown into wave-like section. When dissected out of fresh specimens the septum is smooth, not ridged. It seems to be muscular. The septum is coated on either side by a thin gelatinous layer and it ends inferiorly in a clear, gelatinous, tapered tip. This tip teases easily into strands. There is no sharp dividing line between the pit muscle and the septum. The septa are simply external continuations of the muscle fibres. The septum may thus be regarded as a sort of combination muscle or tendon, formed out of fibres from three main groups of muscles. This is shown diagrammatically in fig. 86.

The septum itself shows numerous small glands (g) scattered through it. The transparent part of the septum (tr) shows tubes in it.

**FILM** (figs. 61 and 62).—Each loculus is occupied by a thin gelatinous film or lamella. It has the size and shape of the loculus and septum, and it tapers away into a thread-like termination inferiorly where, it unites with its fellows to form the byssus stem. Figs. 49 and 85 exhibit the structure diagrammatically.

The film very often comes away with the septum when it is dissected off, and if the septa are thrown into rugæ the film is similarly rugose; it is moulded between the two adjacent septa. Fig. 36 shows the longitudinal section of a ridged film.

It is striated longitudinally, and splits up readily longitudinally. It extends right to the limits of the loculus. It is difficult to get the film separated whole, as it is so thin, and readily splits. Moreover, it is thrown into a curve inferiorly, as the loculus is. The top end of the film is the thinnest part. That means that the loculus is slightly wedge-shaped. The edge of the film is all thready, as if in separating it fibres had been broken that connected it to the glands round the edge of the loculus. The film is lightly reticulated, but the main rows of striæ run longitudinally with cross wrinkles. The upper two-thirds is all punctuated with dots, and it is whitish to the naked eye, while the lower termination is clear and marked by parallel striation (fig. 62). Round the outer rim of the pit are situated among the muscle fibres, the glands which supply the secretion which forms the film.

When the byssus is drawn out of a fresh mussel the films are whitish and they stick together, *i.e.*, they are more or less in a plastic condition. In preserved mussels the film is hard, transparent; the byssus cannot, as a rule, be drawn out of preserved mussels. The septa are contracted and thrown into ridges, which serve to hold the films fast. In the fresh mussel they often slide out easily.

The sheath of the muscle includes a film-like tissue resembling the above film, and both are probably derived from similar glands.

A mussel which had been opened, its adductor muscle being cut, had some of the threads of its byssus attached to its own shell. It was seen to be exerting a strain on the byssus. Part of the white portion of the stem was drawn out of the pit, and the inner soft collar of the neck was everted. The byssus root came gradually out, drawing a final thread of adhesive matter with it. This thread was sticky and connected the root still to the pit. Under the microscope it was seen to be rather granular. The root was bathed in a similar fluid. The soft transparent films were crumpled, but not regularly cross-barred, as in those mussels killed in formaline.

The force exerted on the muscles and on the pit when the byssus root was withdrawn will cause a copious outflow of the secretion from the glands into the loculi. It will lubricate the films in the passage out, and fill the loculi with secretion, which will be moulded into new films.

The films grow, and that process seems to take place as follows:—Round the edge of the loculus the ducts pour out their secretion in a semi-fluid condition as threads. These are moulded in the loculus into a flat sheet, but the film shows its thread formation even in the hard condition. The growth of the byssus may be due to successive pulls upon it, which will result in drawing out the films a little, when the secretion from the glands will pour out to a similar extent, so that the threads which form the film retain their connection by plastic threads right into the gland ducts. In the loculus the film hardens, but does not do so completely, except at its lower extremity, when it comes out into the neck of the pit.

The films thus retain a continuous connection down through the stem of the byssus, and also above with the glands.

The gelatinous termination of the septum dips down between the thread-like terminations of the films as they leave the loculi, and in the neck of the pit the films are moulded tightly into a rod-like stem of the byssus.

It is possible that there is poured out from the ends of the septa a secretion that serves to bind the films together into the byssus stem.

The thin outer skin that clothes the septum on both sides is in its nature similar to the film. In one case pieces of this outer clear layer were bearing what looked like little short fibrillæ.

I made out no cilia on the septum, nor in the neck of the byssus-pit.

*Byssus stem.*

The byssus stem is a bundle of longitudinal plaited fibres. It is of slightly greater diameter at the proximal end than distally. The byssus stem grows independently of the formation of the threads. The growth may be simply due to continued small pulls which the muscles exert on the byssus thread.

When a thread is being formed the foot of the mussel is extended, and its tip having the depression is attached to the object. In this position the groove is closed on every side. The byssus stem passes through it. The secreting surface of small ducts surrounds the stem, and the secretion that is poured out fills the groove, surrounds the stem, and fills up the depression. Now from the short time which is required to make a thread, it is evident that some special force is used to drive the secretion out until it fills the whole groove, neck of pit, and depression. This may be attained by the distension with fluid of the lacunæ between the muscles in the foot. And the internal pressure may be relieved by the issue of the fluid from the median vessel into the depression. This will relieve the sucker and permit of water getting into the groove in the foot. The water would tend to harden the thread. This seems to me to be *modus* of the formation of the thread. In some cases parts of threads are found in the groove of the foot. Some sticky material that had a thread formation was drawn out of the depression at the end of the groove, and it was connected by a thread to what looked like a pore at one side. It stuck to the glass. Under the microscope it was seen to be formed of longitudinal fibres and moulded externally with a crenate edge.

The complete thread (fig. 53) is flattened laterally in its proximal half and is rounder at its distal half. It appears to be made in layers laid one on top of the other. The part of the thread inside the mussel remains pale, that outside grows yellow and finally black. Owing to being flattened the thread shows a core very distinctly in its proximal part. Each layer is corrugated as it is laid on. This layer formation is probably due to the distention of the foot being exerted intermittently at short intervals. The external corrugations on the thread depend on the extent to which the foot is extended. The thread is crossed by fine lines in its whole course. These probably represent rows of gland openings or the division between. I think it is probable that the secretion is pressed out of the ducts in little semi-plastic threads at right angles into the grooves. There they are moulded by the sides of the groove, the complete thread being built up of several layers. The buttons at the ends of the thread were seen in one case to be tinged with violet.

The proximal end of the thread is in the form of a ring round the stem (fig. 57).

When the threads have been laid on in rapid succession a longitudinal section of the stem there shows the bases of the thread overlapping like a series of steps (fig. 52).

The threads may be made so quickly one after the other that the bases overlap and increase the thickness of the stem very much (fig. 56).

In other cases the interval between the formation of the two threads has been such that the stem of the byssus had grown in the interval (fig. 57). The attachment made by the disc to a clear surface, *e.g.*, glass, is very strong. The foot of the mussel seems to a certain extent to clean the surface to which the button is to adhere.

Occasionally the thread breaks as soon as it is formed; sometimes the button alone is seen sticking to the object. Threads may be broken by the muscles putting too great a pull on them. The adherent discs



may loosen their holds. A byssus often contains many black threads carrying their discs that had been pulled away from their points of attachment.

Finally, if the discs are firmly attached, and they generally stick well if lately formed, the mussel can, when it desires to go, draw out the byssus by its roots. Where the stem grows much the threads will become so much the longer, and the mussel may no longer be able to put a tight strain on them. It will then probably form new threads upon which it can exert a strain.

The stem and the thread are formed independently of one another. The former is composed of the fibres from the byssus pit, possibly glued together by secretion from the tips of the septa, while they are moulded into shape by the neck of the pit. The mussel very often attaches some of the threads to its own shell. One advantage which this may have will be to tend to lessen the rocking of the mussel.

A curious condition happened in the case of one mussel. It had attached some of its byssus threads to the bottom of the tank and some to its own shell. It drew out the byssus by its roots, and moved off, but was checked at a little distance by the byssus thread attached to the shell (fig. 69). It, however, when found, had formed new byssus threads on its new situation. Later on it snapped the threads that detained it; they were four in number, and together must have made a fairly strong combination.

#### *The Formation of a new Byssus Stem.*

The rudiment of a new byssus stem is formed by the old root as it is being drawn out. When the films forming the root slip out of the loculi a secretion is poured out by the glands and this secretion accompanies the film outside, and is drawn out of the pit in a thickish thread. The remains of this may be seen attached to cast byssi. The loculi are now full of secretion that will be moulded into films. And this little thread of secretion that is left sticking out in the neck of the byssus pit, and which is continuous with that in the loculi, is sufficient for the mussel to attach a thread to. It will harden at once. This is especially well seen in the byssus tracks where the mussel has simply formed a few threads, and then cast its byssus completely. Fig. 50 shows the formation of threads on a new byssus. Very soon the byssus grows, increasing rapidly to its normal thickness.

The beginning of the stem is shown at (b), and the gradual widening in diameter is shown by an optical section. The root is marked thus (v), and the threads by the letter (t).

The withdrawal of the films seems simply to open the ducts of the glands, and give their secretion free exit. Then by filling the loculus with secretion they seal themselves.

Except for the bases of the threads no rind is found to the stem. There appears to be a sort of outer skin, but it may be simply the flattening of plastered films.

In some cross sections of the byssus stem a cavity was shown in the centre.

The byssus stem probably grows through the strain put on it by the muscles drawing it out bit by bit.

#### *GROWTH OF THE SPOUT-FISH (*Solen siliqua*.)*

Several stages of the spout-fish have been kindly sent by Mr. Wm. MacBride, jr., Pirnmill. They were collected on April 30th.

They are readily sorted into 5 groups, viz., (1) in which the shells measured in length  $4\frac{1}{4}$ ,  $4\frac{3}{4}$ , and  $4\frac{7}{8}$  inches (figs. 87 and 88); (2) having shells  $5\frac{1}{2}$  and  $5\frac{3}{4}$  inches long (fig. 89); (3)  $6\frac{1}{2}$ ,  $6\frac{3}{4}$ ,  $6\frac{7}{8}$  inches long (fig. 90); (4) 7, 7,  $7\frac{1}{8}$ ,  $7\frac{1}{4}$  inches long (fig. 91); (5) 8, 8 inches long (fig. 92).

Two pairs of shells showed a different breadth to practical equality of length, e.g. (a)  $6\frac{3}{8}$  by 1 inches,  $6\frac{1}{2}$  by  $1\frac{1}{8}$  inches; and (b) 7 by 1 inches, and  $7\frac{1}{8}$  by  $1\frac{1}{4}$  inches.

A specimen of what is probably *Solen siliqua*, var. *arcuata*, measured  $5\frac{5}{8}$  inches in length. It is markedly curved. Mr. MacBride informs me that this form is not got of a larger size.

Another specimen, measuring  $7\frac{3}{8}$  inches, had a slight bend on the posterior end of the shell. It may be a variety. It is probable that the samples given represent year groups; but the crux of the question is in deciding the age of the first group. Mr. MacBride regards the first three groups as representing one, two, and three years old respectively. It is probable that spoutfish living in the sand will grow fairly regularly in any one locality.

Except for the age of the first group, which seems to me to likely exceed one year, the interpretation of the other groups as representatives of consecutive year-groups seems to be correct.

#### LITERATURE CONSULTED.

- BRANDT, K.—“Die Fauna der Ostsee.” *Verhandlungen der deutsch. Zool. Gesell.* 1897. Leipzig.
- CALDERWOOD.—“Mussel Culture and the Bait Supply.” London, 1895.
- DONNISON.—Eastern Sea Fisheries. “The Mussel Question.” Boston. Lincolnshire Newspaper and Printing Coy. 1897.
- FULLARTON.—“On Bouchôt Mussel Culture and the Bouchôt Experiment at St. Andrews.” *Ninth Annual Report of the Fishery Board for Scotland*, Pt. III., for the year 1890. Edinburgh, 1891. Pp. 212 *et seq.*
- FULLARTON and T. SCOTT.—“Mussel-Farming at Montrose.” *Seventh Annual Report of the Fishery Board for Scotland*. Pp. 327 *et seq.*, Pl. VII., 1889.
- GARNER.—“On the Anatomy of Lamellibranchiate Conchifera.” *Trans. Zool. Socy.*, London. Vol. II., 1841.
- KING.—“Mussels and Mussel Culture.” *Northumberland Sea Fisheries Committee* Newcastle, 1891.
- LANG, ARNOLD.—Text-Book of Comparative Anatomy. London, 1896.
- LEBOUR.—“The Mussel-Beds of Northumberland.” Maps I-VI. *Northumberland Sea Fisheries Committee. Report on the Scientific Investigations for the year 1906*. Newcastle-on-Tyne, 1907. pp. 28-46.
- MEEK.—(1) “Some of the Mussel-Beds on the East Coast of Scotland, and the Desirability of Forming Mussel-Beds on the Coast of Northumberland.” *Northumberland Sea Fisheries Committee. Report on the Trawling Excursions for the year 1899*. pp. 45-50.
- (2) “The Mussel Experiment on the Coquet.” *Northumberland Sea Fisheries Committee. Report on the Trawling Excursions for the year 1901*. pp. 35 and 36.
- M’INTOSH.—(1) “Notes from the St. Andrews Marine Laboratory (under the Fishery Board for Scotland). I. On the British Species of *Cyanea* and the Reproduction of *Mytilus edulis*, L. *The Annals and Magazine of Natural History*. V., vol. 15. 1885. pp. 148-152.
- (2) “Report on the Mussel and Cockle-Beds in the Estuaries of the Tees, the Esk, and the Humber,” 1891.
- MÖBIUS.—“Ueber Austern u. Miesmuschel Zucht.” Berlin, 1870.
- MÖBIUS, u. MEYER.—“Fauna der Kieler Bucht.” Leipzig, 1866. 1 Bd.
- SCOTT, A.—“Note on the Spawning of the Mussel.” *Ninth Report of the Lancashire Sea Fisheries Laboratory for 1905*. Liverpool, 1901. pp. 36-39.
- SCOTT, A., and BAXTER.—“Mussel Transplantation at Morecambe.” *Fourteenth Report of the Lancashire Sea Fisheries Laboratory for 1905*. Liverpool, 1906. pp. 58-87. Plates XI. and XII.

PLATE XVI.

- Fig. 1. Two-years old mussel, St. Andrews. March. *Nat. size.*  
 " 2. " " " " " " " " " " " "  
 " 3. Mussel opened to show the relation of the foot (f) and byssus (by).  
 " 4. Three-years old mussel, St. Andrews. March. *Nat. size.*  
 " 5. " " " " " " " " " " " "  
 " 6. Ripe Egg of Faroe mussel, *Cam. luc.* Obj. DD: Oc. 2, Zeiss.  
 " 7. Egg of Faroe mussel.  
 " 8. " " " at 1 p.m., June 3rd.  
 " 9. Section of byssus-pit showing glands (g).  
 " 10. Egg of Faroe mussel at 10.30 a.m., June 4.  
 " 11. " " " " " " " " " " " "  
 " 12. Nearly ripe egg of mussel, removed from the mantle. July 1.  
 " 13. Egg of Faroe mussel at 10.30 a.m., June 4.  
 " 14 and 15. Eggs at 3 p.m. June 3. The yolk contents have been squeezed out, leaving real or apparent nuclei.  
 " 16. Unfertilized egg of Faroe mussel: budding.  
 " 17. Egg of Faroe mussel at 1 p.m., June 3rd.  
 " 18. " " " " " " " " " " " "  
 " 19. Enlarged drawing of process from the micropyle of the egg shown in Fig. 18.  
 " 20. Egg of Faroe mussel at 10.30 a.m., June 4.  
 " 21. " " " " " " " " " " " "  
 " 22. " " " " " " " " " " " "  
 " 23. Longitudinal section of byssus-pit and foot, showing muscles (m), glands (g), septum (sep), groove (gr), byssus (by), foot (f).  
 " 24. Sperm of mussel.  
 " 25. Egg of Faroe mussel at 7 p.m., June 3.  
 " 26. Bean-shaped slow-growing mussel, which had been kept for two years in Laboratory. Side view. *Nat. size.*  
 " 27. Bean-shaped slow-growing mussel, which had been kept for two years in Laboratory, view from above. *Nat. size.* Compare with Figs. 31 and 32.  
 " 28. Egg of Faroe mussel at 3 p.m. June, 3.  
 " 29. " " " " " " " " " " " "  
 " 30. " " " " " " " " " " " "  
 " 31. Broad mussel from pond, quick-growing, side view. *Nat. size.*  
 " 32. " " " " " " " " " " " " view from above. *Nat. size.*  
 " Compare with Figs. 26 and 27.  
 " 33. Shows the eversible inner collar (i-c and i'c) of the byssus-pit, outer collar (o-c), byssus (by).  
 " 34. Septum from byssus-pit: glands (g). *Cam. luc.* Obj. a and Oc. 2, Zeiss.  
 " 35. Egg of mussel nearly ripe, July. Part of the yolk contents has been pressed out. Nucleus (n).  
 " 36. Diagrammatic longitudinal section of the film of root of byssus of a preserved mussel.  
 " 37. Byssus-pit and byssus seen from the side. The skin and glands have been dissected off, and the edges of the septa exposed. Anterior side (ant), posterior side (post), muscle (m), septum (sep).  
 " 38. Egg of Faroe mussel at 7 p.m. It has been burst; a "nucleus" remains inside the capsule, and a little collection of protoplasm is attached to the outside of the zona.  
 " 39. Skin of foot seen from inside—showing the longitudinal muscle strands (m), and the glands (g) between them.  
 " 40. Mussel which had a dark amber-coloured frill to the inhalent aperture (in), and a white exhalent aperture (ex).  
 " 41. An apparent nucleus formed by the union of clear protoplasm and yolk granules, both of which had been pressed out of an egg.  
 " 42. Groove of foot opened out to show the cushion lips (l), byssus (by), byssus-pit (by-p), and depression at end of the groove (de).  
 " 43. Mussel that travelled actively by means of its foot (f) along on the level. *Nat. size.*  
 " 44. Mussel (female) that spawned. *Nat. size.*  
 " 45. Foot of mussel, showing yellow glands (y-g) that border the groove in its whole extent.

**R**

- FIG. 46. View of outside of byssus-pit, showing the outer (o-c) and inner collars (i-c and i'c).  
 „ 47. Mussel that had a purple-coloured frill to the inhalent aperture (in), and a purple-coloured exhalent siphon (ex).

## PLATE XVII.

- FIG. 48. Byssus root (r), thread (t), shreds of secretion (sh).  
 „ 49. Diagram of the relation of septa (sep) and the films (f), root (r).  
 „ 50. Root of a new byssus showing the beginning of the byssus-stem (b) and the first threads laid on overlapping one another. The ragged edge of the bases of the first threads are seen at (r). *Cam. luc.* Obj.  $\alpha$  and Oc. 2, Zeiss.  
 „ 51. Transverse section of the foot of the mussel—gland (g), yellow gland (y-g), purple gland (p-g), muscle (m), longitudinal muscle (l-m), median vessel (m-v), lateral vessel (l-v). (Fig. 55 shows an element of the purple gland.)  
 „ 52. Stem of byssus showing the formation of nodes by the overlapping of the bases of the threads (t), stem (st), root (r).  
 „ 53. Drawing of byssus thread—base of attachment to byssus-stem (b), disc for attachment to foreign body (d).  
 „ 54. Transverse section of the groove (gr) of the foot—cuticle (ct), columnar pigmented cells (c-l), purple-coloured glands (p-g), secreting surface (sec-s), secretion (sec). *Cam. luc.* Apoch. Obj. 8 mm., Oc. 2, Zeiss.  
 „ 55. Element of purple gland of foot. *Vide* Fig. 51.  
 „ 56. Mussel showing inhalent aperture (in) and exhalent siphon (ex) widely open. May, 1907.  
 „ 57 and 58. Byssus-stem (st) showing the attachment of the bases of threads (t). The bases overlap and are of one size. The stem has no rind. The root has apparently brought away some of the septa from the byssus-pit. *Cam. luc.* Obj.  $\alpha$  and Oc. 2, Zeiss. (Another view of this byssus-stem is shown in Fig. 58.)  
 „ 59. Drawing to show the glands (g) which surround the byssus-pit, and in which the muscles (m) are embedded—foot (f).  
 „ 60. Longitudinal section through the byssus-pit and foot to show the connection of the median vessel (m-v) with the end depression of the groove (gr)—purple gland (p-g), yellow gland (y-g), muscle (m), septum (sep).  
 „ 61 and 62. Parts of film. *Cam. luc.* Obj.  $\alpha$  and Oc. 2, Zeiss.  
 „ 61A. Egg of Faroe mussel at 10.30 a.m., June 4.  
 „ 63. Byssus-pit split longitudinally to show muscles (m), gland (g), byssus-pit (by-p), groove (gr), byssus stem (st).  
 „ 64. Diagram to show the relations of the films (f) and the tips of the septa (sep). The tips of the septa unite with the films, but they do not go far into the stem.  
 „ 65. Section of byssus-pit—position of byssus (by), collar of pit (c), groove (gr), film (f), septa (sep), posterior deep groove (d-gr), yellow gland (y-g), glandular tissue (g).  
 „ 66. Byssus pit laid open—groove of foot (gr), byssus (by), outer collar (o-c), inner collar (i-c).

## PLATE XVIII.

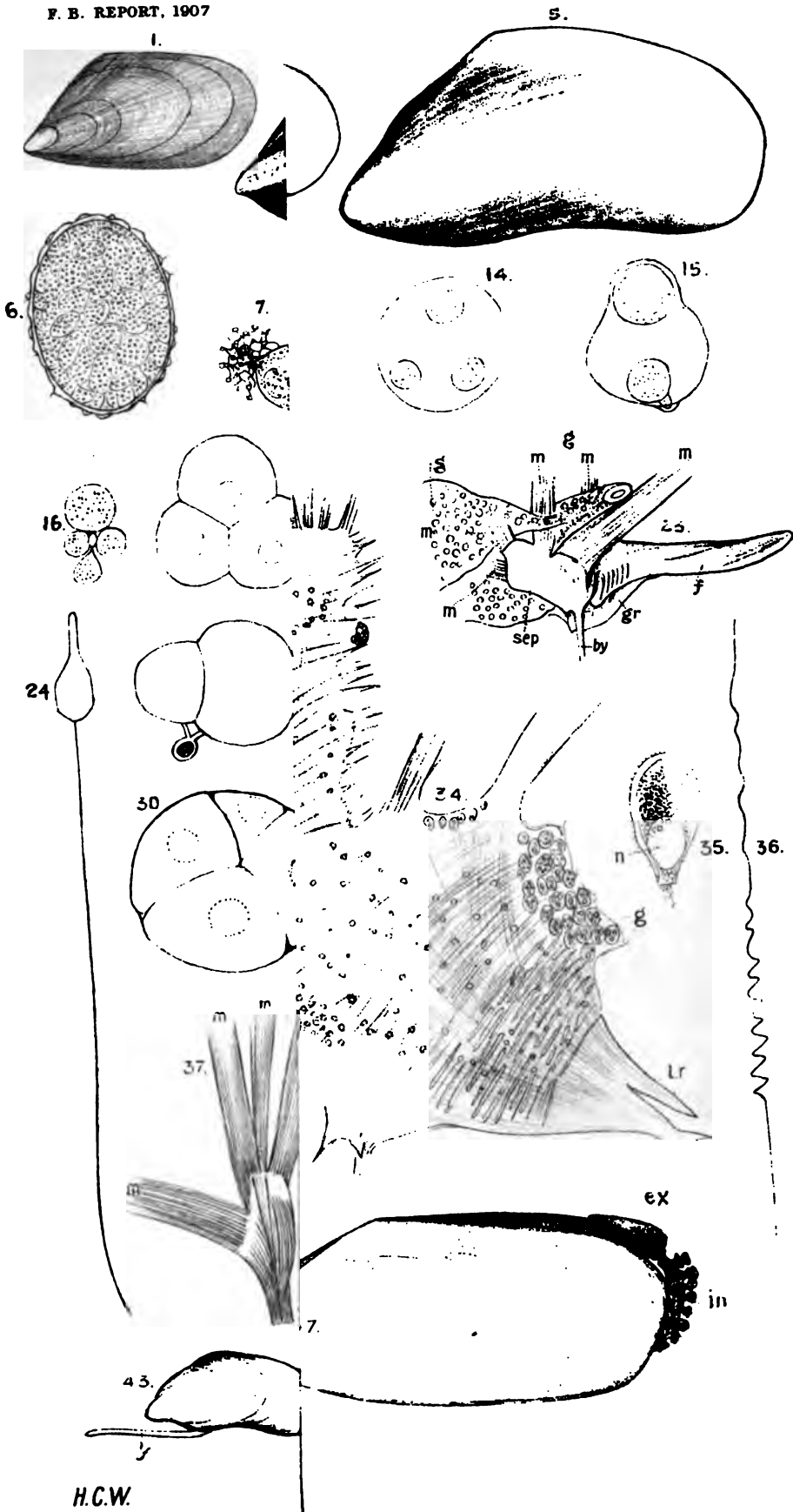
- FIG. 67. Track of mussel—discs without hairs (p).  
 „ 68. „ „ „  
 „ 69. Mussel attached to glass by discarded byssus.

## PLATE XIX.

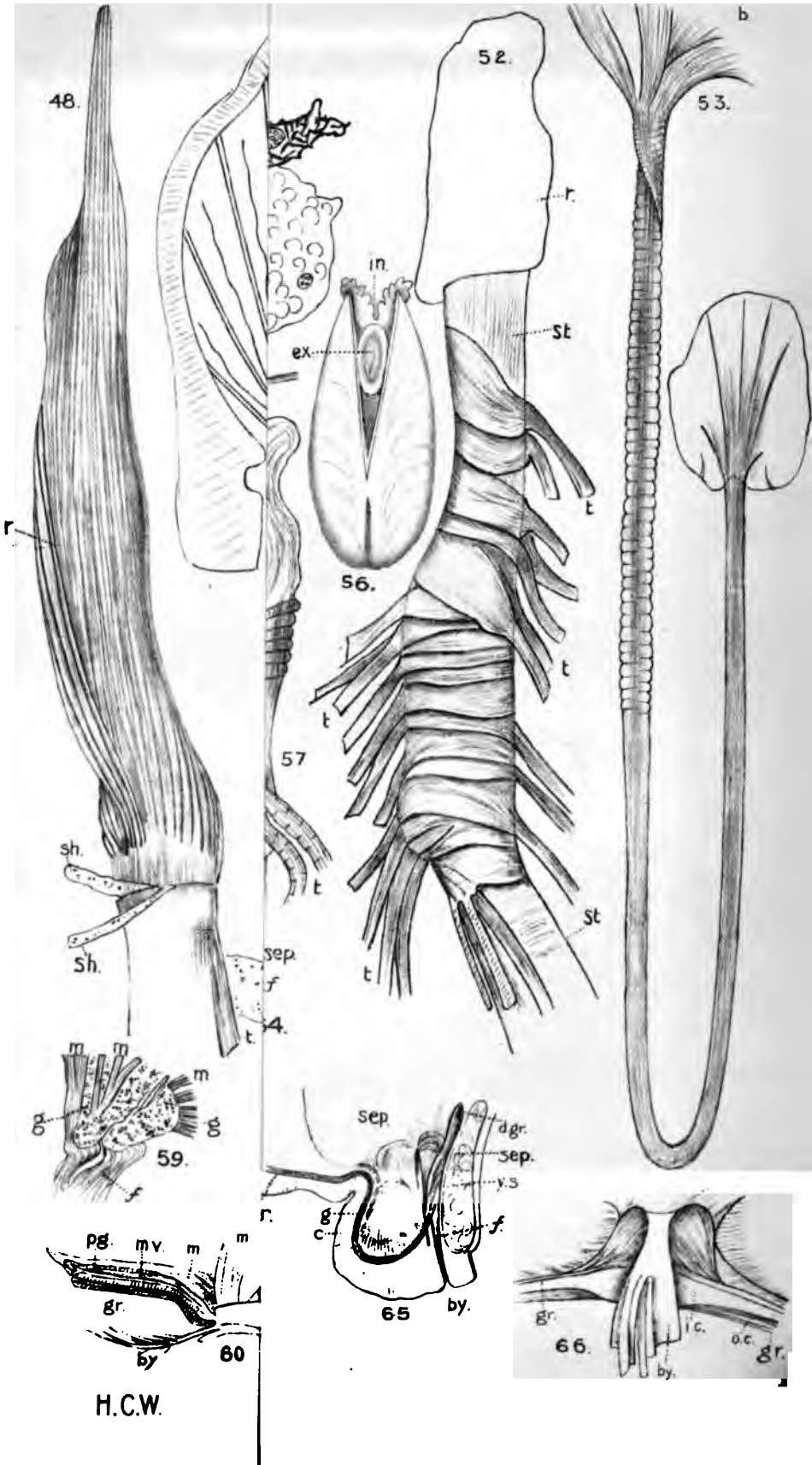
- FIG. 70-80. Successive drawings of the same mussel to show the formation of byssus-threads—disc without a hair (p).  
 „ 81. Drawing of a mussel that raised itself on end on the bottom of a box, and attached itself by numerous threads in 18 hours.  
 „ 82. Mussel with byssus slack.  
 „ 83. „ „ hauled tight.  
 „ 84. Drawing of Faroe mussel showing heap of spawn at its round end—spawn (sp).

## PLATE XX.

- FIG. 85. Diagrammatic section of byssus-pit to show septa and films.  
 „ 86. Diagram to show the morphology of the septum, viz., that it is formed by the united tendons of three sets of muscles

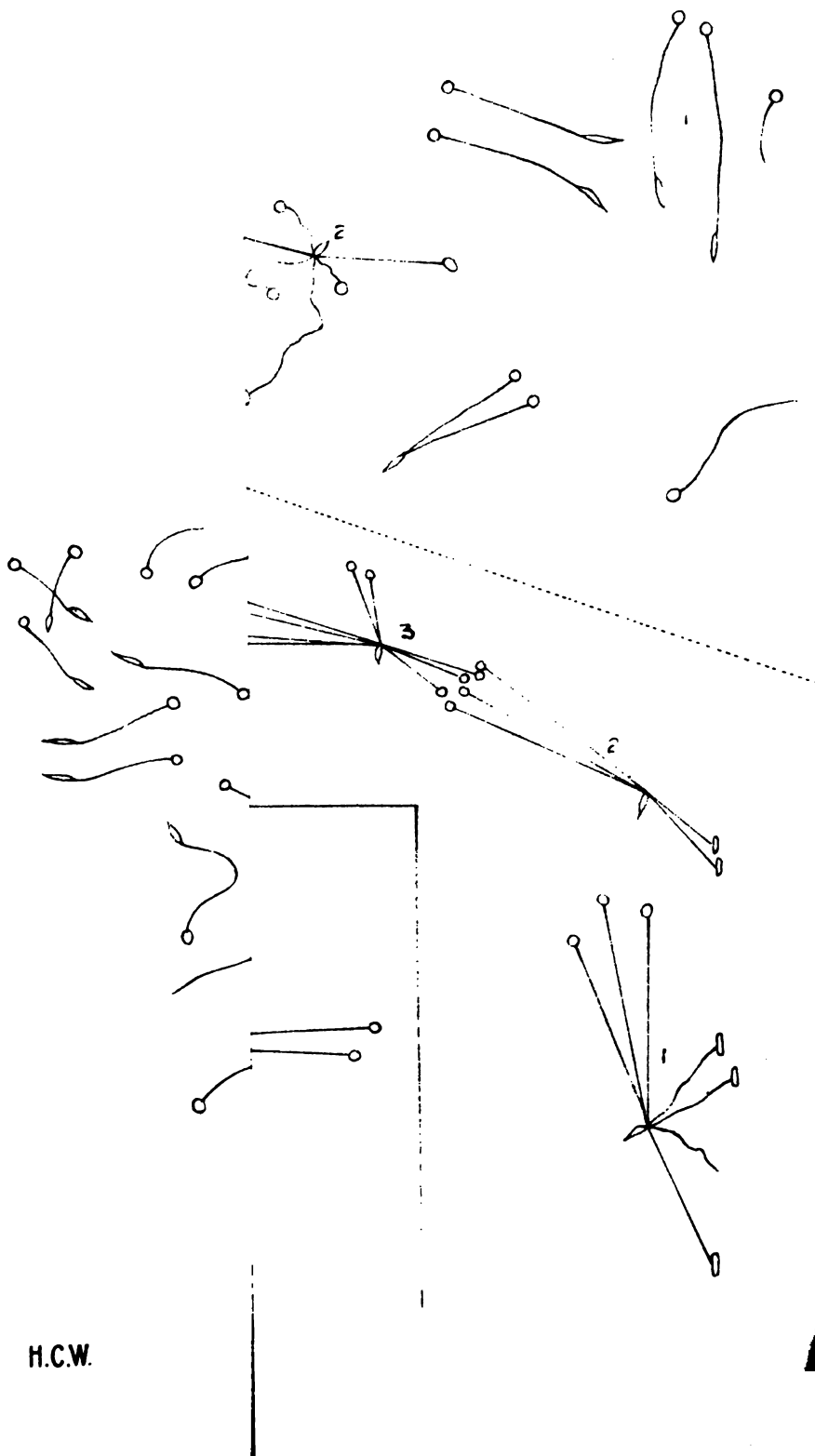




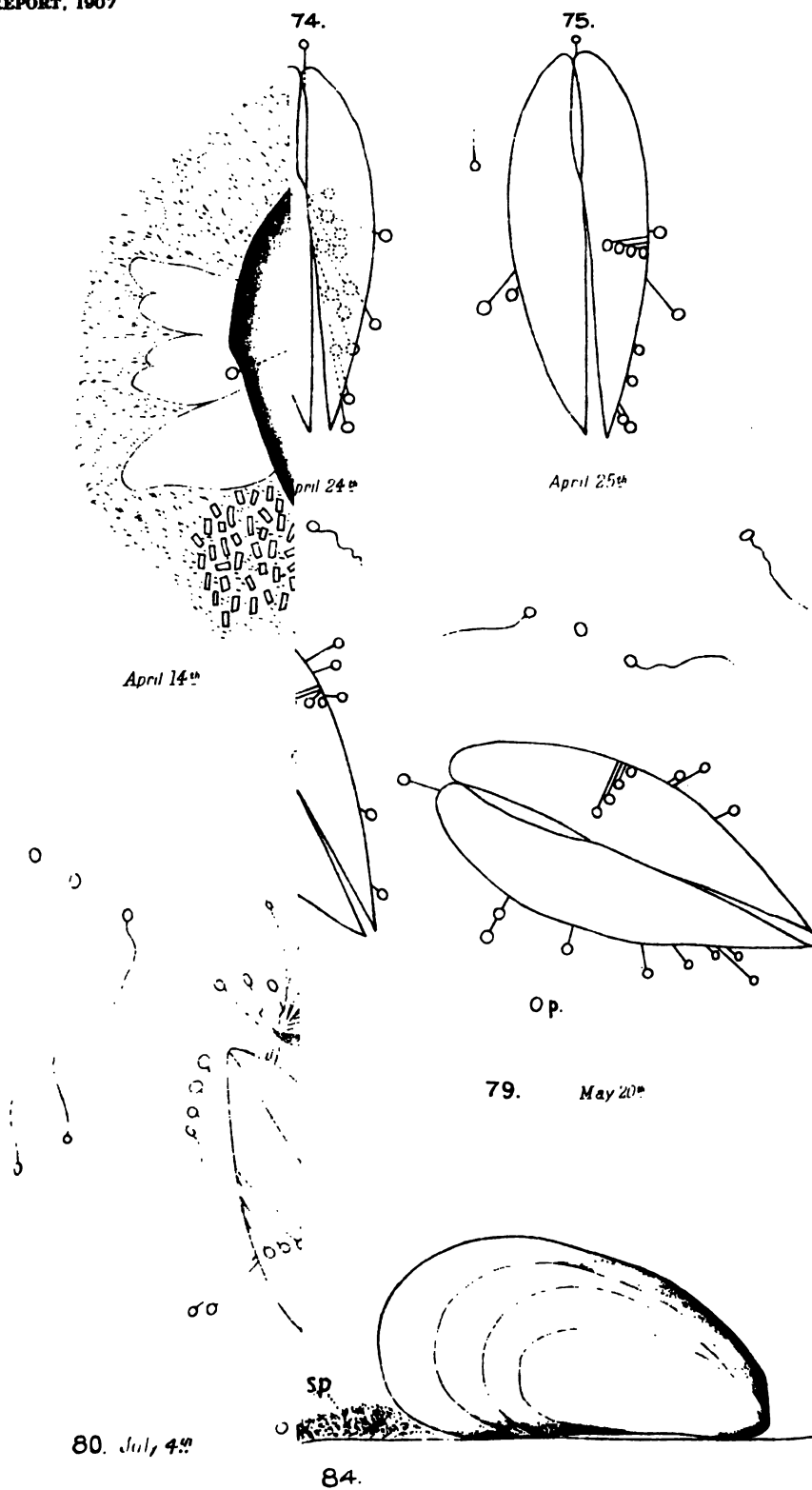






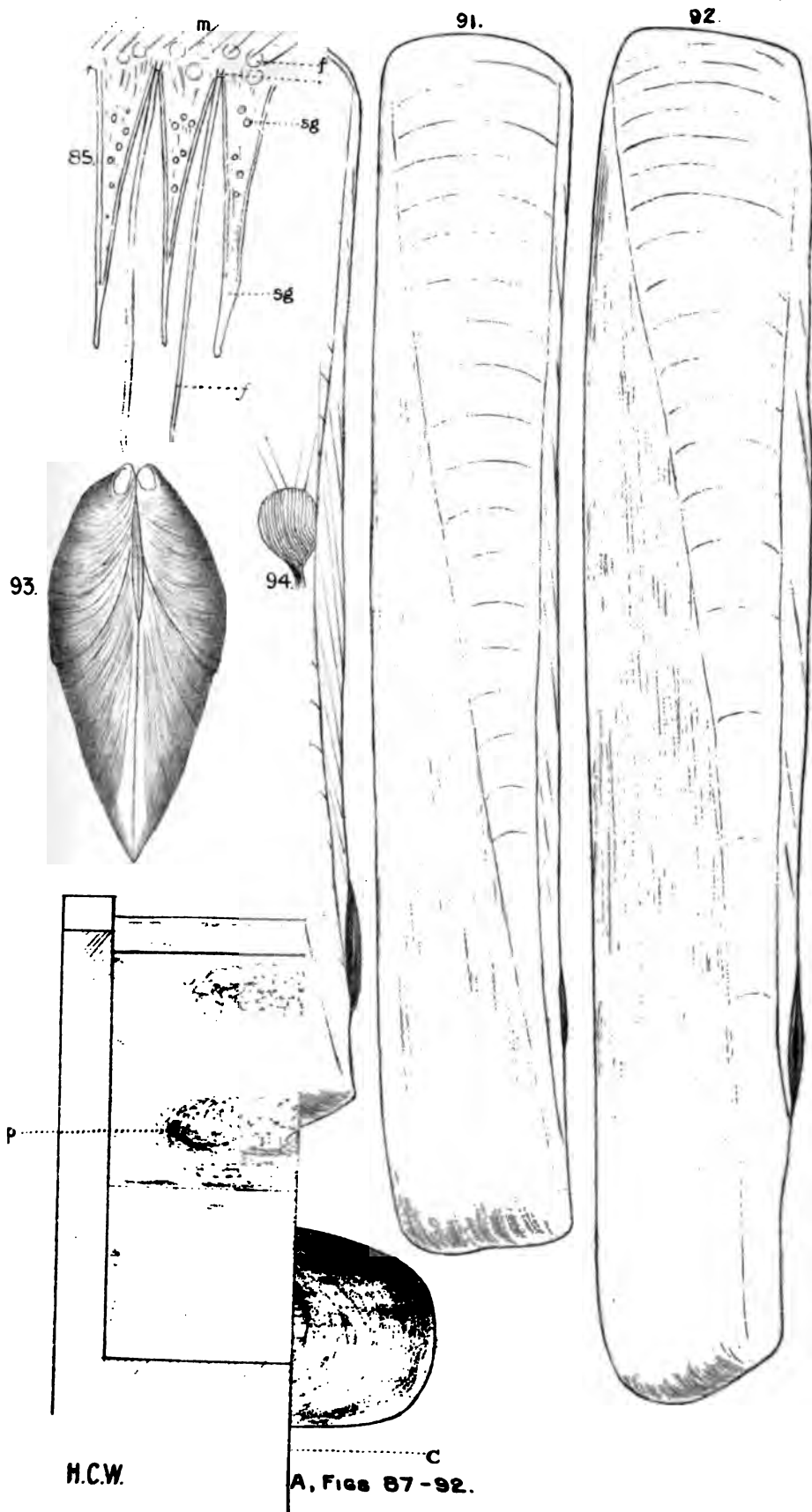






H.C.W.







- FIG. 87. Spout-fish (*Solen siliqua*), nat. size— $4\frac{1}{2} \times \frac{3}{4}$  inch, April 30.
- „ 88. „ „ „  $4\frac{1}{2} \times \frac{1}{8}$  „ „
- „ 89. „ „ „  $5\frac{3}{8} \times \frac{1}{8}$  „ „
- „ 90. „ „ „  $6\frac{1}{2} \times 1\frac{1}{8}$  „ „
- „ 91. „ „ „  $7\frac{1}{8} \times 1\frac{1}{8}$  „ „
- „ 92. „ „ „  $8 \times 1\frac{1}{4}$  „ „
- „ 93. Drawing (natural size) of a mussel that had grown in the pond at Bay of Nigg. July 20, 1907. View from above.
- „ 94. Diagrammatic median section of the byssus-pit.
- „ 95. Side view of mussel shown in fig. 93.
- „ 96. Drawing of excretum of mussel.
- „ 97. „ „ „ section.
- „ 98. Drawing showing the cloud formed in tank by the discharge of sperms by two examples of the horse-mussel (*Modiolus modiolus*).
- „ 99. Transplanted mussel. (St. Andrews.) A-B is the size of the original seed ; B-C is the increase after transplanting.

V.—REPORT ON THE OPERATIONS AT THE MARINE FISH HATCHERY, BAY OF NIGG, ABERDEEN, IN 1906. By Dr. T. WEMYSS FULTON, F.R.S.E., Scientific Superintendent.

In the Annual Report for last year\* an account was given of the arrangements at the hatchery and the alterations which had been made, together with a number of plates showing the hatchery, ponds, etc. It need only be said here that the adult plaice from which the spawn is obtained are confined in a large tidal pond, where they are kept throughout the year and fed on mussels. At the spawning season the eggs are shed into the water of the pond, from which they are collected by a large gauze net and transferred into the hatching apparatus. They are maintained in the apparatus until the young hatch out, the length of this period depending directly upon the temperature of the water. At the commencement of the spawning season, when the temperature of the water is low, the duration of the period of incubation is on the average about three weeks; at the end of the season, when the temperature has risen considerably, it occupies about a fortnight. The larval fishes, after they are hatched out, are kept in the apparatus for several days, until the yolk-sac is partly absorbed, and they are then placed in the sea.

It is estimated that, including both periods—the time of incubation of the eggs and the period during which the larvæ are retained—protection is conferred upon the eggs and larvæ for about half of the time that naturally elapses from the spawning of the eggs until the complete transformation of the larval fish, when the characteristic adult form and habit is assumed.

The success of the hatching operations depends very largely upon two circumstances—an adequate supply of eggs and a sufficient supply of pure water. In order to obtain a large supply of eggs it is necessary that the number of adult fishes in the spawning pond should be large. Hitherto the method adopted of obtaining the adult brood stock was as follows:—By the authority of the Board a steam trawler was permitted to trawl within the territorial waters, and more particularly within the Moray Firth and Aberdeen Bay. By an arrangement with the owners of the trawler and the skipper the hatchery attendant accompanied the vessel on such occasions, taking with him and fitting up on deck a number of large wooden tubs, through which a constant circulation of sea water was maintained by means of the donkey-pump. Into these tubs the plaice which were selected from the catches brought on board were placed, and when the vessel returned to Aberdeen they were transferred in tanks to the hatchery pond. The plaice required for the purposes of the hatchery were thus obtained gratis, the rest of the catch of fish being the property of the owners, and regarded by them as sufficient compensation for their trouble.

By the method described the stock of adult plaice at the hatchery has been maintained since the beginning of the work at Aberdeen, for although a large proportion of the stock of one season survives to the next, there is always a considerable loss which requires to be made up each year. Unfortunately, as mentioned in last Annual Report, the trawler which was engaged in this work at the beginning of December, 1905, was stranded in Aberdeen Bay, and owing to the loss of life occasioned thereby the Board have thought it right to refrain from making use of such vessels for inshore work. In consequence of this the stock was not renewed, and the supply of spawn, as mentioned

\* *Twenty-third Annual Report*, Part III., p. 108.



below, was much under the supply in former years. Under present circumstances it is not possible to get supplies of living adult plaice from the ordinary commercial trawlers working in the North Sea. As a rule the quantity of plaice obtained by them from near grounds in any single voyage is small, and it would require many expeditions to obtain a sufficient number for the hatchery; and the fish would, moreover, have to be purchased at their market value, and the cost of this can scarcely be borne by the present vote for scientific investigations. It is only within the sandy bays near the shore that large quantities of plaice can be secured.

The eggs were first observed in the spawning pond last year at the beginning of February, which is later than usual, owing to the smaller number of adult fishes in the pond. The spawning gradually increased towards the end of the month, and, as usual, was greatest in March and in the early part of April, declining towards the end of the latter month, and ceasing in the early part of May, a few eggs being obtained on the 13th. The number of eggs obtained in each of the months was estimated to be:—February, 796,000; March, 3,320,000; April, 3,290,000; May, 80,000, making a total of 7,486,000. In the previous year the estimated number was 40,110,000, so that the decrease, for the reason mentioned, has been considerable.

The estimated number of fry which were hatched out and put into the sea was 4,406,000, the death-rate being thus equivalent to about 41 per cent., which is unusually high. The principal cause of this was the impurity of the water and a scarcely adequate supply, especially towards the end of March and the early part of April. Owing to the stormy weather there was sometimes difficulty in filtering the water properly; and it was found that the arrangement of the filtering apparatus in the re-built hatchery was defective, and the "head" of water was insufficient to furnish a plentiful supply. The fry were put into the sea off Girdleness and Aberdeen on five occasions—in March, April, and May, the last lot being set free on the 23rd of the latter month.

The temperature of the water varied from 1·5 C. (34·7 F.) to 10·7 C. (51·3 F.) during the hatching season. It was lowest in the early part of March. The specific gravity was under 27 on only six occasions; it was usually about 27·5–27·8, and the lowest was 26·6.

The number of the eggs of the plaice collected from the spawning pond and the number of fry hatched out are as follows in the different years at Bay of Nigg:—

	Eggs Collected.	Fry Hatched.
1900, ..	43,290,000 ..	31,305,000
1901, ..	63,370,000 ..	51,800,000
1902, ..	72,410,000 ..	55,700,000
1903, ..	65,940,000 ..	53,600,000
1904, ..	39,600,000 ..	34,780,000
1905, ..	40,110,000 ..	15,790,000
1906, ..	7,486,000 ..	4,406,000
	<hr/> 332,206,000	<hr/> 247,381,000

It may be mentioned that the expense in connection with the hatching work is comparatively small, since it is carried on in conjunction with the Marine Laboratory, and without any additional staff. The total expenditure for extra coals, food for the fishes, etc., is estimated at under £80.

During the season the hatchery was visited by delegations of fishermen from the counties of Argyll, Bute, Caithness, and Elgin, under arrangements made with the various County Councils.

TABLE I.—Showing the Daily Progress at the Hatchery, and the Temperature and Specific Gravity of the Water.

Date.	Eggs Collected.	Dead Eggs Removed.	In Pond.			In Hatchery.	
			Temperature.		Sp. Gr.	Temperature.	
			Cent.	Fahr.		Cent.	Fahr.
February 5	...	...	2.2	36.0	27.9	...	...
" 6	...	...	2.6	36.7	27.8	...	...
" 7	...	...	2.9	37.2	27.8	...	...
" 8	...	...	3.0	37.4	27.8	...	...
" 9	7,000	...	...	...	...	...	...
" 10	7,000	...	2.1	35.8	27.7	2.1	35.8
" 11	...	...	...	...	...	...	...
" 12	3,000	...	2.1	35.8	27.7	...	...
" 13	...	...	2.1	35.8	27.8	...	...
" 14	13,000	...	3.1	37.6	27.6	2.8	37.0
" 15	...	...	2.7	36.9	27.7	...	...
" 16	133,000	...	2.6	36.7	27.7	...	...
" 17	13,000	...	2.2	36.0	27.7	...	...
" 18	...	...	...	...	...	...	...
" 19	80,000	10,000	3.2	37.8	27.7	...	...
" 20	...	...	3.0	37.4	27.8	...	...
" 21	100,000	20,000	2.2	36.0	27.7	...	...
" 22	...	...	...	...	27.6	...	...
" 23	110,000	...	2.7	36.9	27.8	2.2	36.0
" 24	...	...	...	...	...	...	...
" 25	...	...	...	...	...	...	...
" 26	170,000	4,000	2.2	36.0	27.8	...	...
" 27	...	...	...	...	...	...	...
" 28	160,000	...	2.4	36.3	27.8	...	...
March 1	...	...	1.8	35.2	27.8	...	...
" 2	160,000	...	1.5	34.7	27.8	1.3	34.3
" 3	...	24,000	1.6	34.9	27.8	...	...
" 4	...	...	...	...	...	...	...
" 5	200,000	...	3.2	37.8	27.7	...	...
" 6	...	...	4.0	39.2	27.6	5.2	41.4
" 7	280,000	40,000	4.6	40.3	27.6	...	...
" 8	...	140,000	4.6	40.3	27.6	...	...
" 9	420,000	...	3.6	38.5	27.6	...	...
" 10	...	...	3.0	37.4	27.7	...	...
" 11	...	...	...	...	...	...	...
" 12	...	40,000	...	...	...	...	...
" 13	440,000	...	1.9	35.4	27.5	...	...
" 14	480,000	80,000	1.6	34.9	27.7	...	...
" 15	...	...	...	...	...	...	...
" 16	240,000	88,000	2.5	36.5	27.6	...	...
" 17	...	...	3.2	37.8	27.6	...	...
" 18	...	...	...	...	...	...	...
" 19	440,000	27,000	...	...	...	...	...
" 20	...	...	4.5	40.1	27.6	...	...
" 21	260,000	40,000	...	...	...	...	...
" 22	...	...	4.9	40.8	27.5	...	...
" 23	...	...	5.2	41.4	27.3	...	...
" 24	...	660,000	4.1	39.4	27.3	...	...
" 25	...	...	...	...	...	...	...
" 26	400,000	...	3.6	38.5	27.2	4.0	39.2
" 27	...	...	3.6	38.5	27.0	...	...
" 28	...	...	...	...	...	...	...

TABLE I.—continued.

Date.		Eggs Col-lected.	Dead Eggs Re-moved.	In Pond.			In Hatchery.	
				Temperature.		Sp. Gr.	Temperature.	
				Cent.	Fahr.		Cent.	Fahr.
March	29	...	240,000	4.0	39.2	27.0	...	...
"	30	...	...	5.2	41.4	27.0	...	...
"	31	...	...	5.2	41.4	27.0	...	...
April	1	...	...	...	...	...	...	...
"	2	500,000	...	5.8	42.4	27.0	...	...
"	3	...	187,000	...	...	...	...	...
"	4	400,000	...	6.0	42.8	26.8	...	...
"	5	...	520,000	6.0	42.8	27.1	...	...
"	6	380,000	200,000	6.4	43.5	27.2	...	...
"	7	...	...	...	...	...	...	...
"	8	...	...	...	...	...	...	...
"	9	280,000	130,000	...	...	...	...	...
"	10	...	...	7.4	45.3	27.1	...	...
"	11	100,000	...	8.0	46.4	27.1	...	...
"	12	...	...	7.8	46.0	27.2	...	...
"	13	420,000	...	...	...	...	...	...
"	14	...	...	7.8	46.0	27.1	...	...
"	15	...	...	...	...	...	...	...
"	16	180,000	...	8.0	46.4	26.8	...	...
"	17	...	...	7.4	45.3	27.0	...	...
"	18	200,000	160,000	...	...	...	...	...
"	19	...	90,000	7.2	44.9	27.0	...	...
"	20	220,000	...	...	...	...	...	...
"	21	...	...	7.3	45.1	27.2	...	...
"	22	...	...	...	...	...	...	...
"	23	440,000	...	6.7	44.1	27.4	...	...
"	24	...	...	6.1	43.0	27.4	...	...
"	25	80,000	...	6.1	43.0	27.5	...	...
"	26	...	...	6.2	43.2	27.4	...	...
"	27	60,000	180,000	6.8	44.2	27.4	...	...
"	28	...	...	...	...	...	...	...
"	29	...	...	...	...	...	...	...
"	30	50,600	...	7.6	45.7	27.4	...	...
May	1	...	...	...	...	...	...	...
"	2	40,000	...	7.9	46.2	27.6	...	...
"	3	...	...	8.6	47.5	27.0	...	...
"	4	26,000	...	9.3	48.7	26.8	...	...
"	5	...	...	9.1	48.4	26.8	...	...
"	6	...	...	9.0	48.2	27.2	...	...
"	7	...	...	9.6	49.3	27.4	...	...
"	8	12,000	...	10.7	51.3	27.3	...	...
"	9	...	...	9.8	49.6	26.6	...	...
"	10	...	200,000	...	...	...	...	...
"	11	...	...	9.6	49.3	27.3	...	...
"	12	...	...	9.7	49.5	27.2	...	...
"	13	2,000	...	9.8	49.6	26.6	...	...
Totals,	-	7,486,000	3,080,000					

## VI.—SOME OBSERVATIONS ON THE FOOD OF THE HERRING.

By THOMAS SCOTT, LL.D., F.L.S., Mem. Soc. Zool. de France.

The organisms which constitute the food of the herring—their various kinds, their distribution, and their influence on the movements of the fish—have for a long time engaged the attention of students of marine natural history, and it is now many years since the Fishery Board for Scotland commenced investigations into the nature of the food of the herring and of various other problems connected with the herring fisheries of Scotland.

In 1885 an important paper on the food of the herring was contributed to the Fourth Annual Report of the Fishery Board for Scotland by the late George Brook, F.L.S., in collaboration with Mr W. L. Calderwood, the present Inspector of Salmon Fisheries for Scotland. In this paper the results of the examination of between fourteen and fifteen hundred stomachs of herring containing food are given in detail in a Table which fills eighteen pages of the Report.

The stomachs had been received from various places all round Scotland, including the district of Berwick-on-Tweed, the Firths of Forth and Tay, Aberdeen, the Moray Firth District, Loch Broom, West Ross-shire, and the Firth of Clyde, including Loch Fyne. All these stomachs were such as contained food that could in most cases be identified. Many other stomachs had been examined, but as they proved to be empty or the food they contained was so disintegrated by the digestive fluids as to be undistinguishable, they were by the authors excluded from the paper in question.

The observations which follow, and which may be considered as supplementary to the paper by Brook and Calderwood, describe the results obtained from the examination of fully five hundred herrings' stomachs, selected from various fishing centres in Scotland. The Table appended contains a summarised statement of the number of stomachs and of the dates when they were examined, and also of the localities from whence they were sent.\*

TABLE I.

Dates when the stomachs were examined.	Number of stomachs examined.	Localities whence the fish were sent.
December 1904	17	Loch Fyne.
February 1905	55	Loch Fyne, Loch Broom.
June „	122	Campbeltown, Loch Broom, Stornoway, Anstruther.
July „	93	Loch Fyne, Campbeltown, Stornoway.
August „	19	Kilbrennan Sound (Pirnmill).
September „	33	Loch Fyne, Carradale.
December „	38	Loch Fyne.
January 1906	31	Campbeltown.
September „	11	Loch Fyne.
October „	11	Loch Fyne.
November „	12	Loch Fyne, Shetland, Wick, Peterhead.
December „	11	Loch Fyne, Girvan, Rothesay.
January 1907	17	Clyde, Stornoway.
February „	19	Campbeltown, Rothesay, Stornoway.
March „	22	Campbeltown, Skipness, Stornoway.
April „	5	Skipness, Machrie Bay (Arran).

\* I desire to acknowledge the assistance I have received in this inquiry from my colleague, Dr. H. C. Williamson.

Rather more than half the number of stomachs examined were found to be empty or the food they contained could not be satisfactorily determined; fully forty-five per cent. of them were the stomachs of female fish, and fifty-two per cent. males; a few had their reproductive organs so immature that it was considered doubtful whether they were milters or spawners. Those found to contain food that could be identified numbered two hundred and forty-three. Of these stomachs about fifty-two and a half per cent. were those of female fishes, two were doubtful, and the others those of male fishes, as shown in the subjoined Table.

TABLE II.

TABLE showing the proportion of stomachs containing food and those containing no food that could be identified, the proportion of males to females, and the names of the districts from which they were sent.

Names of the Districts.	Stomachs containing Food.			Stomachs containing No Food.			Totals of ♀ and ♂ and ?			Total Number of the Stomachs Examined.
	♀	♂	?	♀	♂	?	♀	♂	?	
Loch Fyne	42	36	1	26	32	0	68	68	1	137 Stomachs
Clyde	42	41	1	41	48	4	83	89	5	177 "
Loch Broom	0	0	0	40	35	0	40	35	0	75 "
Stornoway	27	24	0	2	6	0	29	30	0	59 "
Anstruther	8	13	0	15	20	0	23	33	0	56 "
Peterhead, Wick, Shetland.	8	0	0	0	0	0	8	0	0	8 "
Totals	127	114	2	124	141	4	251	255	6	
	243			269			512			512 "

*Description of the Food observed in the Stomachs of Herrings sent from Loch Fyne, the Firth of Clyde, Loch Broom, Stornoway, Anstruther, and other places.*

In describing the food observed in these herrings' stomachs, the various samples from the same place or district are arranged together under the name of the district and according to the date on which they were examined, and for convenient reference the names of the districts arranged as in Table II.

#### (1) LOCH FYNE HERRINGS.

December, 1904.—The stomachs of seventeen herrings sent from Loch Fyne were examined at this date. They all contained some food, but it was so disintegrated by the digestive fluids that only in three examples could the nature of it be determined, and even in these to a limited extent. The food in these three stomachs appeared to consist exclusively of Schizopods belonging to the Euphausiidae. Neither the species or genus could be satisfactorily determined, but probably they were all young *Nyctiphanes, norvegica* as that species is common in Loch Fyne.

### Part III.—Twenty-fifth Annual Report

February, 1905.—The stomachs of six herrings from a sample sent from Loch Fyne contained each a considerable amount of *Calanus helgolandicus*.

July, 1905.—No more herrings from the Loch Fyne district were submitted for examination till July, when the stomachs of twenty-three specimens were examined. These form part of a sample captured about the end of April and retained during the interval in a cold storage chamber. All the stomachs contained food, and in most of them the quantity observed was considerable, and with two exceptions consisted entirely of Copepoda—*Calanus helgolandicus* being apparently the only species represented. In the two exceptions referred to the food consisted of post-larval fishes and *Calanus*, and my notes indicate that the food in these two was more decomposed than in the others, due probably to the presence of the young fishes.

September 22nd, 1905.—The stomachs of eight herrings were examined. They were from a sample sent from Strachur, and captured two days previously. Two of them were considerably distended, but contained no food; three contained some red-coloured matter, but there was nothing that could be identified; one was packed full with *Calanus*; in the other two there was some red-coloured stuff with fragments of Copepods mixed up with it.

December 11th, 1905.—The stomachs of thirty-four herrings sent from Loch Fyne were examined. Sixteen were found to be empty, or contained some red-coloured matter probably derived from *Calanus*, but no trace, even of their appendages, could be detected. All the others contained the remains of *Calanus*, the specimens being in a number of cases tolerably whole, in others they were more or less fragmentary. There was also present in many of the stomachs a quantity of red-coloured oily matter derived probably from the *Calanus*. The fish whose stomachs contained food comprised 6 ♀ and 12 ♂, and the others 7 ♀ and 6 ♂.

January, 1906.—The stomachs of twenty herrings sent from Strachur were, with one exception, found to contain food, which appeared to consist entirely of *Calanus*. Some of the stomachs contained a considerable quantity of food. The fishes comprised 11 ♀ and 8 ♂. The empty stomach belonged to a male fish.

September 8th, 1906.—Eleven stomachs from Loch Fyne herrings were examined at this date. One contained some food too much digested for identification. One contained *Calanus*, *Centropages hamatus*, *Metridia lucens*, and young Euphausiidae. One contained *Calanus*, *Centropages hamatus*, *Evadne nordmannii*, and some Decapod larvae, and another contained a small quantity of *Calanus* only. The food observed in five of the others consisted entirely of *Nyctiphanes norvegica*, while two contained the remains of Euphausiidae which probably also belonged to *Nyctiphanes*, but they were too much digested to be satisfactorily determined.

October 12th, 1906.—The eleven stomachs of Loch Fyne herrings examined at this date all contained food, in most cases in considerable quantity. The sexes represented comprised 9 ♀ and 2 ♂. The food observed in two stomachs consisted chiefly of *Calanus*, but *Centropages hamatus*, *Temora longicornis*, *Oithona similis*, and Decapod larvae were also present. A small quantity of food, apparently all *Calanus*, was observed in another. A third contained a moderate quantity of *Calanus*, but *Temora longicornis* was also present. The food observed in other four appeared to consist entirely of Euphausiidae, and were probably all *Nyctiphanes*—at least this was the only species that could be identified.

One contained *Calanus*, *Metridia lucens*, another a small number of Decapod larvæ, while one contained the remains of a considerable number of Euphausiidae (*Nyctiphanes* probably), and a few post-larval fishes which appeared to be sand-eels.

November 9th, 1906.—The stomachs of four herrings from Loch Fyne examined at this date contained a considerable quantity of food which appeared to consist entirely of *Calanus*. The fishes comprised 2 ♀ and 2 ♂.

December 18th, 1906.—A small sample consisting of the stomachs of three Loch Fyne herrings (2 ♀ and 1 ♂) contained a small quantity of food of a semi-fluid nature, but no trace of anything that could be identified.

## (2). THE CLYDE.

June 2nd, 1905.—Examined the stomachs of twenty-seven herring sent from Campbeltown. One contained one or two fish scales, another was filled with *Nyctiphanes*, and two contained some red-coloured matter with fragments of *Calanus* mixed up with it; the others were either empty or contained nothing that could be identified.

July 3rd, 1905.—Examined the stomachs of thirty-six herrings also from Campbeltown, but only five of them contained food that could be determined even in a limited degree. These fishes had been captured on 11th March, and kept in a cold storage chamber. In one the food consisted of Annelids (Chætopoda) and Amphipoda (Hyperiidæ), while the other four contained the remains of Crustacea, apparently belonging to *Calanus*.

August 9th, 1905.—The stomachs of nineteen herrings from Pirnmill, Kibbrennan Sound, were examined at this date, but captured on the 26th of the preceding month. Seven were empty or did not contain anything that could be identified. Ten contained food which appeared to consist entirely of Schizopods (Euphausiidae), probably all *Nyctiphanes norvegica*,—at least those specimens that could be satisfactorily distinguished belonged to that species. In one which contained only a small quantity of Crustacean remains, the only species identified was *Centropages hamatus*, while another contained Crustacean remains that could not be determined with certainty.

September 2nd, 1905.—Twenty-five stomachs of herrings from Carra-dale were examined, but they had been captured on July 26th. They were all empty, and many of them were distended with air. The fishes comprised 14 ♀ and 11 ♂. In several cases the stomachs were covered externally with white clean fat.

January 21st, 1906.—Eleven stomachs of herrings from Campbeltown contained food that consisted chiefly of *Nyctiphanes norvegica*, some *Calanus* being also present. Most of the stomachs were full, and some were considerably distended by the large quantity of food they contained. Five of the herrings were females and six males.

December, 1906.—No further stomachs of herrings from the Clyde were submitted for examination till December, when four from a sample sent from Girvan and the same number from a sample from Rothesay were examined. Those from Girvan all contained food that could be identified. One contained a moderate quantity of food which appeared to consist entirely of *Calanus* in a fragmentary condition. One contained Euphausiidae very much digested, while the food observed in the other two consisted of Euphausiidae and *Calanus*.

Three of those from Rothesay contained only a small quantity of food, which consisted entirely of *Calanus*, and the other was well filled with

apparently the same organisms, but too much decomposed to be satisfactorily identified.

January, 1907.—The stomachs of fifteen herrings from the Clyde were examined; they comprised small samples from two or three different places. Five sent from Rothesay contained food that appeared to consist entirely of young Euphausiidae, some of which that could be identified, and probably the others also, belonged to *Nyctiphanes norvegica*. The food observed in other six stomachs consisted of *Calanus* only, of which there were a considerable quantity. In other three the food consisted of *Calanus* (chiefly), *Sagitta* and young Euphausiidae, and one was distended with food consisting chiefly of *Nyctiphanes*, but some *Calanus* were also present.

February, 1907.—The number of stomachs from Clyde herrings examined in February was thirteen. Eight were from two samples sent from Campbeltown, and five from a sample from Rothesay. Four of the stomachs from Campbeltown herrings contained food that consisted entirely of *Calanus*. One contained a large quantity of *Nyctiphanes*, while the food observed in the other three consisted of *Calanus* and *Nyctiphanes*. The stomachs of the five herrings from Rothesay differed much from those from Campbeltown; two were empty, two contained a small quantity of red-coloured matter, but nothing that could be distinguished, while the only thing distinguishable in the other consisted of a few fish scales.

March, 1907.—The stomachs of eighteen herrings from the Clyde were examined in March; they included eleven from Campbeltown, four from Skipness, and three from Girvan. All the stomachs of the Campbeltown herrings contained food that could be identified. In four the food appeared to consist entirely of *Calanus*; other organisms may have been present, but the food had become so much decomposed that only the *Calanus* could be satisfactorily identified. The food in one stomach consisted entirely of young Euphausiidae, while the contents of the other six comprised *Calanus* and Euphausiidae in varying proportions. In three cases the Euphausiidae present in these stomachs were certainly *Nyctiphanes norvegica*, and probably all those observed belonged to the same species. Of the four stomachs from Skipness herrings two were empty; one contained a small quantity of food, but it was too much decomposed for identification, while the other which was tolerably well filled contained Euphausiidae and *Calanus* in a partially digested condition. The contents of one of the stomachs of the Girvan herring consisted of *Calanus*, *Pseudocalanus elongatus*, young Euphausiidae, and some fish eggs. This stomach was moderately well filled with food, but the other two were empty.

April, 1907.—The stomachs of a few herrings from Skipness and Machrie Bay (Kilbrennan Sound) were examined—two from the former and three from the latter place. Those from the Skipness herring contained so much food as to be somewhat distended with it; one was filled for the most part with *Calanus*, but three moderately large *Nyctiphanes* were also present; the other contained *Nyctiphanes* and *Calanus* in about equal quantities. On the other hand, the stomachs of the herrings from Machrie Bay, though at first sight apparently containing a moderate amount of food, were found on examination to consist only of some red-coloured stuff that could not be identified, though probably it was part of the remains of some *Calanus*.

### (3) LOCH BROOM.

February 1st and 2nd, 1905. The stomachs of forty-nine herrings captured in Loch Broom, West Ross-shire, were examined in February,



1905 ; a considerable proportion of them were entirely empty, a number of the others contained some red-coloured fluid, probably derived from organisms captured by the fishes, but there was nothing that could be identified. In several instances the stomachs were distended with air, the result perhaps of fermentation. The fishes represented by these stomachs comprised 29 ♀ and 20 ♂.

June 1st, 1905.—Thirty-six stomachs of herrings sent from Loch Broom were examined at this date. The results obtained resembled generally those of the previous sample. A number of the stomachs were found to be entirely empty, and the others contained some semi-fluid matter usually of a reddish colour, but no trace of anything that could be identified with certainty. In some cases, as in the previous sample, the stomachs were considerably distended with air.

#### (4) STORNOWAY.

June, 1905.—The stomachs of thirteen herrings, being part of a sample sent from Stornoway on May 19, were examined in June. They all contained food which, with one exception, consisted for the most part of post-larval fishes. In the one stomach referred to, however, no fishes were observed, but the food consisted entirely of Decapod larvæ, of which there were a considerable quantity. Eight stomachs contained fishes only, while the others contained both fishes and crustacean larvæ. The fishes appeared to be mostly sand-eels, but Clupeoids may, in some cases, have also been present; the food, however, had already undergone digestion to some extent, and the species could not in a few examples be satisfactorily determined. One stomach at least was crammed full with post-larval sand-eels, and two others were fairly well filled with the same kind of fish. The only other organism observed in addition to the Decapod and fish larvæ was a single specimen of *Caligus rapax*. All the thirteen herrings were females with undeveloped ovaries.

July 7th, 1905.—The stomachs of thirty-four herrings sent from Stornoway were examined. Eight of them were either empty or contained a small quantity of semi-fluid matter, but nothing that could be identified. The other twenty-six contained food which consisted for the most part of post-larval fishes, chiefly sand-eels. In only two examples were fish remains apparently absent, and the food in one of these consisted of the remains of Calanoids and in the other of Euphausiids, but these organisms were so much disintegrated that the species could not be satisfactorily determined.

Eight stomachs were distended with the large quantity of young fishes they contained, while as many more were tolerably well filled with them. In a few cases *Calanus* were found in the same stomachs with the fishes. Seven of the thirty-four herrings were spawners, but there was no indication that difference in sex resulted in any difference in the nature or quantity of the food consumed.

January 17th, 1907.—The stomachs of two herrings (♀ and ♂)—part of a sample from Stornoway—contained each a small quantity of food consisting of fragments of Schizopods (Euphausiids); they were so disintegrated as to be almost indistinguishable, but the only fragments that could be identified with certainty belonged to *Nyctiphanes*.

February 14th, 1907.—Six herrings (5 ♀ and 1 ♂), from another sample sent from Stornoway, had all of them food in their stomachs. Two were tolerably full, but the quantity in the others was small. One contained post-larval fishes—apparently Clupeoids, but the food observed in the others consisted only of *Nyctiphanes*.

March 16th, 1907. The stomachs of four herrings (3 ♂ and 1 ♀), part of a sample also from Stornoway, contained each a fair quantity of food. In one, which was tolerably well filled, the food consisted partly of *Nyctiphanes* and partly of Hyperiidæ (*Parathemisto*), but in the other three it consisted of *Nyctiphanes* only.

(5) ANSTRUTHER, FIRTH OF FORTH.

June 6th, 1905.—The stomachs of fifteen herrings from a sample sent from Anstruther were examined for food; with one exception, they were all male fishes. Only three of the stomachs contained food; all the others were empty. The food observed consisted entirely of *Parathemisto obliqua*. One of the stomachs containing *Parathemisto* was that of a female fish.

June 10th, 1905.—Twenty-five stomachs from another sample of herrings sent from Anstruther were examined. Eleven were found to be empty, and of the others one contained the remains of crustacea—probably fragments of *Parathemisto*—but they could not be satisfactorily determined. The food observed in five of the others appeared to consist entirely of the species of Amphipod just referred to, while that contained in the other eight stomachs included both *Parathemisto* and Euphausiidae. These Schizopods, though they could not be identified with absolute certainty, appeared to belong to *Thysanoessa* sp. Four of the stomachs (two from female and two from male fishes) were distended with the large amount of food they contained, and which consisted of Amphipods and Schizopods in about equal proportions.

(6) PETERHEAD, WICK, AND SHETLAND.

November, 1906.—The stomachs of a few herrings representing samples sent from Peterhead, Wick, and Shetland, were examined in November. Two, which were those of fishes belonging to a sample from Peterhead, contained each a tolerable amount of food. In the one case it consisted for the most part of the Decapod larvæ and in the other of *Calanus helgolandicus*.

Three stomachs of herrings from a sample sent from Wick were also found to be well supplied with food. In two of them the food appeared to consist entirely of *Metridia lucens*, and in the other of young fishes which were too much decomposed to be satisfactorily identified.

The remaining three stomachs were those of herrings from a sample sent from Shetland. Like the others, they each contained a considerable amount of food, but in this case it consisted entirely of Euphausiidae, but it was not in a condition to permit of an exact determination. From a careful examination of the fragments, however, I think it highly probable that they belong to the genus *Thysanoessa*.

I now append in tabular form the names of the various organisms referred to in the preceding notes.

[TABLE.

TABLE III.

List of organisms observed in the preceding notes with the localities where the herrings were sent from.

Names of the Organisms.	Loch Fyne.	Clyde.	Loch Broom	Stor- noway.	Anstr- uther.	Peter- head.	Wick.	Shet- land.
Post-larval fishes—Clupeoids (?)	+	...	...	× ?	...	...	+ ?	...
" " Sand-eels	+ ?	...	...	++	...	...	...	...
Fish eggs	...	+	...	...	...	...	...	...
Fish scales	...	+	...	...	...	...	...	...
Nyctiphanes norvegica	++	++	...	+	...	...	...	...
?Thysanoessa, sp.	...	...	...	...	+	...	...	++
Euphausiidae	++	++	...	++	++	...	...	...
Hyperia galba ?	...	+	...	...	...	...	...	...
Parathemisto obliqua	...	...	...	+	++	...	...	...
Evadne Nordmanni	+	...	...	...	...	...	...	...
Calanus helgolandicus	++	++	...	+	...	++	...	...
Pseudocalanus elongatus	...	++	...	...	...	...	...	...
Centropages hamatus	+	+	...	...	...	...	...	...
Temora longicornis	...	...	...	...	...	...	...	...
Metridia lucens	+	...	...	...	...	...	++	...
Oithona similis	...	...	...	...	...	...	...	...
Caligus rapax	...	...	...	+	...	...	...	...
Decapod larvae	+	...	...	++	...	++	...	...
Annelida—Chaetopoda	...	+	...	...	...	...	...	...
" Sagitta	...	++	...	...	...	...	...	...

NOTE—The sign + indicates that the organism was generally not very plentiful in any stomach examined. ++ indicates that the organism occurred in at least some of the stomachs in considerable quantity.

It will be observed from this Table and from that in Brook and Calderwood's paper in the *Fourth Annual Report of the Fishery Board for Scotland*, that the food of herring captured off the coasts of Scotland consists mainly of four or perhaps five groups or organisms, viz., (1st) Post-larval fishes, (2nd) Amphipoda, (3rd) Copepoda, (4th) Schizopoda, and (5) Decapod larvae, and a few remarks on each of these groups may not be out of place here.

1st—Post-larval fishes. The post-larval fishes most frequently mentioned by Brook and Calderwood are Clupeoids—chiefly young herrings and sprats. Sand-eels are only recorded eleven times, from places all on the East Coast, and were from herring taken at various times during the year, from January to August. They occurred usually in quantity. In the stomachs examined for this paper, sand-eels in quantity were only observed in herrings from Stornoway, and a few doubtful examples were noticed in Loch Fyne herrings. Clupeoids were seldom observed in the fishes examined for this paper.

2nd—Amphipoda. The only species of Amphipoda that appear to be of much importance as herring food belong to the Hyperiidæ, and those that have been most frequently recorded are *Hyperia galba* and *Parathemisto obliqua*. The first is the form commonly mentioned by Brook and Calderwood, but it has been rarely met with in the stomachs examined for this paper. Hyperiidæ have been met with in the stomachs of herrings chiefly from the East Coast and during the first three and the last months of the year, but they have also been occasionally observed in June and July. The authors referred to above do not appear to have obtained them in the stomachs of any herrings from the West Coast. They occurred, however, in March in three stomachs of

herrings sent from Stornoway, which is a West Coast station (see notes under Stornoway). It is an interesting question why the Hyperiidæ should so frequently occur in the stomachs of East Coast herrings and so sparingly in those from the West Coast.

3rd—The Copepoda. The most important of the Copepod species as herring food is undoubtedly *Calanus*. It will be observed that the name given in my list to this form is *Calanus helgolandicus*, Claus, but after all it may only be a smaller form of *Calanus finmarchicus*, Gunner, for, with the exception of size, the differences between them is not very marked, and a familiarity with the two forms is necessary to enable one to separate them—but this is a question that need not be discussed here.

*Calanus* is usually observed in greater quantity in stomachs of West Coast herrings, and especially of those from the Clyde and Loch Fyne, than in those from East Coast fishes, and it is noteworthy that the species, though common enough in the Firth of Forth, appears to form a very small portion of the food of herrings captured in that estuary. In Brook and Calderwood's paper Copepoda are recorded on only two occasions from herrings sent from the Firth of Forth, and they were not observed at all in the stomachs of the herrings sent from Anstruther and examined for this paper. *Calanus* has been obtained in the stomachs of Loch Fyne and Clyde herrings, frequently in considerable quantity, from April till November, in those from Stornoway in May and June, and in those from Shetland in April. Other species of Copepoda are sometimes observed in the stomachs of herrings, i.e. *Centropages hamatus* and *typicus*, *Temora longicornis*, *Metridia lucens*, *Pseudocalanus elongatus*, *Acartia* sp. and *Oithona similis*, but seldom in any quantity, and are only of interest as bearing on the extensive bill of fare from which the herring may select its food.

4th—Schizopoda. All the Schizopoda found in the stomachs of herrings caught off the Scottish coasts are, with few exceptions, members of the family Euphausiidæ, and belong to one or other of the three genera *Nyctiphanes*, *Rhoda* (better known perhaps as *Boreophausia*) and *Thysanoessa*. On the other hand, Schizopoda belonging to the family Mysidæ such as *Schistomysis spiritus*, Norman, and *Macromysis flexuosa* (O. F. Müller), which at times are met with in swarms, and other species of less frequent occurrence as *Leptomysis gracilis*, *Gastrosaccus spinifer*, but which are also widely diffused in our coastal waters, are rarely observed amongst the food of herrings. The only Schizopod mentioned by Brook and Calderwood, other than species belonging to the Euphausiidæ, is a *Siriella*, and it is recorded from the stomach of a herring from Tarbert, Lower Loch Fyne. One notable characteristic of the Euphausiidæ is that they all possess phosphorescent organs, which appear to be entirely wanting in the Mysidæ. This power of becoming luminous which the Euphausiidæ possess may explain to some extent why they receive so much attention from the fish, while the others are as seldom found in their stomachs.

The Euphausiidæ may be considered as equal to or even of greater importance than the Calanoida as a food supply for herring both on the East and West Coasts. Moreover, they have been observed in the stomachs of herrings more or less all through the year from January to December, though they appear to be more commonly met with during the earlier and later months of the year.

The Schizopod most in evidence, and most frequently recorded as herring food, is *Nyctiphanes norvegica* (M. Sars), while *Thysanoessa* and *Rhoda* are only occasionally mentioned; these two forms may, however,

occur more frequently than the records of them would seem to indicate, for it is quite possible they may sometimes be included under the more general name of Euphausiidae. The use of this less definite name is often rendered necessary owing to the disintegrated condition of the food, which, though perfect enough to show the relationship of the organisms composing it with the family referred to, are too incomplete to permit of the satisfactory identification of the species or even of the genus to which they belong.

5th—Decapod larvæ. In the observations on the food of herrings given under each district, it will be observed that Decapod larvæ, though they may occasionally be found in considerable numbers in a few of the stomachs examined, they do not appear to hold a very important place in the herrings' bill of fare. Of the stomachs containing food examined for this paper, Decapod larvæ were observed in scarcely  $3\frac{1}{2}$  per cent. of them, and the percentage of records for these larval forms in Brook and Calderwood's paper was even less. This infrequency of their occurrence in the stomachs of herrings, as compared with *Calanus*, can hardly be ascribed to the rarity of these organisms, for at times they are present in the sea in considerable numbers, as shown in plankton gatherings. It has to be remembered, however, that many of these larvæ are provided with a tough carapace and a spiny armature of a somewhat formidable character, which may tend to make herrings reluctant to attack them if other food of a more harmless kind be within reach.

Some other forms, i.e., *Pseudocalanus*, *Centropages*, *Temora*, &c., among the Copepoda, *Evdadne*, as representing the Cladocera, *Sagittu*, and other Annelida, and the eggs and scales of fishes have also been recorded, but they occur so very sparingly as to suggest that their presence with the other organisms in the stomachs may be due to their having been accidentally captured by the fish while in pursuit of other species.

In dealing with a subject like this, it sometimes happens that a question emerges which, though not bearing directly upon it, is yet of interest because of its negative character. In studying the food of herring it soon becomes evident that *Calanus*, for some reason, forms an important part of it, and one likely reason, though it may not be the only one, is that this Copepod abounds everywhere throughout the wide area where herring fisheries are carried on. It has also been shown that the herring does not gather its food from the water merely by using its gills as a kind of seive, but hunts for and captures the organisms it lives on, and this seems to indicate that the fish may be able to some extent to discriminate between forms it prefers and those it dislikes. But though it may be able to do so, it is doubtful if it can distinguish differences that separate closely-allied species, as, for example, between *Calanus* and *Pseudocalanus*, or between that species and *Temora*, or *Metridia*, except that the *Calanus* is larger than the others. It is not surprising, therefore, to find that while the herring apparently prefers *Calanus*, other species should occasionally be present amongst its food, especially if they are moderately common. Keeping this in view, it is interesting to note that in the published accounts relating to the food of Clyde and Loch Fyne herrings there is not, so far as I know, a single record of *Euchaeta norvegica* having been observed amongst the food contained in their stomachs. This *Euchaeta* is now known to be generally common and at times abundant in Loch Fyne and it is moderately frequent in other portions of the Clyde area, but in none of the samples of Clyde herrings submitted for examination has *Euchaeta* been observed as part of their food. No doubt this Calanoid appears to be a true deep-water form, but it is also occasionally obtained amongst plankton collected

comparatively near the surface of the water, and thus comes quite within the reach of the herrings. It is a large species, much more so than *Calanus*, but not too large for herring to swallow, seeing that the Euphausiidae are so frequently captured by them. The *Euchætas* are also rich in oily matter, and apparently of as much value as *Calanus* for herring food, yet the herring appears to reject them.

The stomachs examined for this paper number, as already stated, five hundred and twelve. Two hundred and forty-three contained food of a more or less definite kind, while two hundred and sixty-nine were empty or their contents could not be identified. Each of these two groups comprised a nearly equal number of spawners and milters. In the first the females are rather in excess of the males, while in the other the number of males is slightly the greater, but whether food was present or absent, or showed variation in its amount or kind, nothing was observed which could be ascribed to difference in the sex of the fish.

#### "GUT-POKE" IN HERRING.

The term "gut-poke" in herring has long been familiar to fishermen on the West Coast.

In an interesting paper by the late George Brook, F.L.S., entitled—"A Report on the Herring Fishery of Loch Fyne and Adjacent Districts,"\* a short paragraph is devoted to the subject of gut-poke in herring, and it is stated that almost all the herrings in Loch Fyne are liable to the complaint, and that in the month of June the majority of them were in this condition; he also directs attention to the deterioration in the market value of herrings affected by gut-poke.

In the summer of 1894, Dr. Fulton, the Scientific Superintendent of the Fishery Board, desired me to visit Tarbert to make some inquiries into the food of herrings, and suggested that the question—"What is gut-poke in herring?" might receive some attention. Certain inquiries were accordingly made concerning this matter and the results embodied in a short communication to Dr. Fulton, and in the remarks which follow I have incorporated some of the results referred to in that communication. And I would remark, first, that the term "gut-poke" is applied to that condition in herrings when their stomach and intestines are distended with food of a soft and oily nature, such as *Calanus*, post-larval Clupeoids, and the like, the quantity of food in the stomach being so great that it passes into the intestines without being properly digested. When such herrings are captured decomposition rapidly sets in, and they soon become useless and even dangerous as food.

"Gut-poke" is not necessarily limited or peculiar to large or small fishes, but, on the other hand, it seems to be most frequently observed in those with immature reproductive organs. The gut-poke condition is seldom noticed in herrings which are sexually mature or nearly so. But though overfeeding appears to be the immediate cause of gut-poke, herrings are frequently obtained which have a considerable amount of food in their stomach without the gut-poke condition being present.

It is doubtful if a really satisfactory explanation can be given about the true cause of gut-poke in herrings, i.e., the reason why at certain times a seemingly abnormal desire for food affects them, and they feed ravenously till the stomach and intestines become gorged, but whatever the cause may be it is apparently only of temporary duration.

\* *Fourth Annual Report of the Fishery Board for Scotland* (1886), p. 47.

When under the influence of this abnormal craving the fish sometimes approach the surface of the water even during the middle of the day, and have been observed by fishermen greedily feeding on *insects* (probably Copepoda) and young fishes, and this is confirmed by the fact that several of the herrings I examined at Tarbert at the time referred to had their stomachs filled with young herring or sprats about an inch and a half in length. This ravenous desire for food has been ascribed to some disease in the fish, but Mr Brook was inclined to doubt this. Herrings which are finest in quality have usually their stomach and intestines almost empty and their internal organs covered with white healthy fat.

## INDEX.

- Acartia*, 268.  
 Age of the common mussel, 237.  
 Anstruther district, fluctuations in herring fishery in, 97.  
 Ascidians, commensals of, 215.  
 Ayrshire, herring fishery on coast of, 41, 42, 45-62.
- BALLANTRAE Bank, routes by which herrings approach, 62.  
 — statistics of herring fishery on, 49.  
 — district, catch of herrings within limits of, 1863-1887, 109.  
 — statistics of herring fishery in, 46.  
 — proportion of herrings taken in the Solway,  
*Boreophausia*, 268.
- Calanus*, 262, 263, 264, 267, 268, 269.  
 — *finmarchicus*, 268.  
 — *helgolandicus*, 262, 266, 267, 268.  
*Caligida*, 216.  
*Caligus rapax*, 265, 267.  
 Campbeltown district, limits of, 62.  
 — catch of herrings within limits of, 1863-1887, 109.  
 — statistics of herring fishery in, 62.  
 — and Inveraray districts, statistics of herring fishery in, 92.  
*Centropages*, 269.  
 — *hamatus*, 262, 263, 267, 268.  
 — *typicus*, 268.  
 Chemical composition of herring, 197.  
 Copepoda from Scottish seas, 209.
- DECAPOD larvæ as food for herrings, 269.  
*Dinemoura*, 216.  
*Doropygida*, 212.
- EAST coast, fluctuations of herring fishery on, 98.  
*Echthrogaleus*, 216.  
*Eucheta norvegica*, 269.  
*Evadne nordmanni*, 262, 267.
- FIRTH of Clyde, fluctuations in herring fishery in, 98.  
 — quantities of barrels of herrings taken, 1863-1887, 109.  
 — statistics of fishermen since 1825, 27.  
 — statistics of fishing boats since 1825, 27.  
 — statistics of herrings cured since 1809, 23.
- Firth of Clyde, statistics of herring fishery in, 94.  
 Fishermen, scientific and technical instruction to, 7.  
 Food of herring, 260.  
 — of Clyde herrings, 263.  
 — of Firth of Forth herrings, 266.  
 — of Lochbroom herrings, 264.  
 — of Lochfyne herrings, 261.  
 Food-value of the herring, east coast, 197.
- GARELOCH, herring fishing in, 46.  
*Gastrosaccus spinifer*, 268.  
 Glasgow district, catch of herrings within limits of, 1863-1887, 109.  
 Greenock district, catch of herrings within limits of, 1863-1887, 109.  
 — great fishing in, 1868, 42.  
 — limits of, 40.  
 — statistics of herring fishery in, 40.  
 Growth of common mussel, 221, 233, 237; horse mussel, 233.  
 — of spout-fish (*Solen siligua*), 251.  
 "Gut-poke" in herring, 270.
- Harriella simulans*, 209, 210.  
 Hatchery, annual expense of maintenance of, 257.  
 — visits of fishermen to, 257.  
 Hatching of plaice, 256.  
 Herring, chemical composition of, 197.  
 — of "fulls," 198, 199, 200, 202, 204.  
 — of "maties" of east coast, 200, 203, 204, 205, 206.  
 — of spents, 201, 203, 205.  
 — food-value of east coast, 197.  
 — food of, 260.  
 — food of, Clyde, 263.  
 — food of, Firth of Forth, 266.  
 — food of, Lochbroom, 264.  
 — food of, Lochfyne, 261.  
 — food of, Stornoway, 265.  
 — "gut-poke" in, 270.  
 — spawning of, on Ayrshire coast, 47.  
 Herring fishery, description of seine-net, 16.  
 — description of drift-nets, 17.  
 — on Ayrshire coast, 41, 42, 45-62.  
 — in Ballantrae district, 46.  
 — in Campbeltown district, 62.  
 — in Gareloch, 44, 46.  
 — in Greenock district, 41.  
 — in Inveraray district, 76.  
 — in Kyles of Bute, 33-40.



Herring fishery in Loch Long, 34-40.  
 — in Loch Riddon, 32-40.  
 — in Lochryan, 51-55, 57, 59, 60, 61.  
 — in Loch Striven, 33-40.  
 — in Port Bannatyne Bay, 33, 35.  
 — in Rothesay district, 31.  
 — in Sound of Kilbrennan, 63-76.  
 — fluctuations in, in Anstruther district, 97.  
 — in, in Clyde, 98.  
 — in, on east coast, 98.  
 — in, in Loch Carron district, 97.  
 — in, in Lochfyne, 98.  
 — in, in Peterhead district, 97.  
 — in, on west coast, 98.  
 — influence of moon on catch of herrings, 99.  
 — investigations in Clyde on, 15.  
 — Fishermen's Association, 69.  
 — methods of fishing in Clyde, 15.  
 — great fishing at Greenock, in 1868, 42.  
 — great fishing in Kyles of Bute, 33, 34, 35, 39, 40.  
 — penetration of upper reaches of Clyde by shoals, 95.  
 — poor, in Lochfyne, 82, 91.  
 — previous enquiries into, in Clyde, 17.  
 — relation between the yield in Campbeltown and Inveraray districts, 93.  
 — relative importance of the different methods of fishing in Clyde, 16, 22.  
 — statistics of herrings cured in Inveraray district since 1809, 25.  
 — of herrings cured in Clyde since 1809, 23.  
 — of herrings cured and used fresh in Lochfyne, 1844-1862, 25.  
 — of, in Campbeltown district, 62.  
 — of, in Clyde, 23, 29.  
 — of, in Campbeltown and Inveraray districts, 92.  
 — of, in Greenock district, 40.  
 — of, in Inveraray district, 76.  
 — of, in Lochfyne, 76.  
 — of, in Rothesay district, 31.  
 — of, in Upper Lochfyne, 79.  
*Hyperia ulba*, 267.  
 INFLUENCE of moon on catch of herrings, 99.  
 Inveraray district, limits of, 76.  
 — catch of herrings within limits of, 1863-1887, 109.  
 — statistics of herrings cured since 1809, 25.  
 — statistics of herring fishery in, 76.  
 — statistics of fishermen since 1825, 27.  
 — statistics of fishing boats since 1825, 27.

*aophonte simulans*, 209.  
*aophontodes typicus*, 209, 211.  
*epimysis gracilis*, 268.  
 Loch Carron district, fluctuations in herring fishery in, 97.  
 Lochfyne, fluctuations in herring fishery in, 98.  
 — poor herring fishing in, 82, 91.  
 — statistics of fishermen in, from 1825, — statistics of herrings cured and used fresh, 1844-1862, — statistics of herring fishery in, 76.  
 — Upper, decline in number of fishermen and boats in, 28.  
 — statistics of herring fishery in, 79.  
 Lochryan, herring fishing in, 51-55, 57-61.  
 — great herring fishing in, 61.  
*Macromysis flexuosa*, 268.  
*Metridia*, 269.  
 — *lucens*, 262, 263, 266, 267, 268.  
*Modiolus modiolus*. See Mussel, horse.  
 Moon, influence of, on catch of herrings, 99.  
 Movements of common mussel, 242.  
 Mussel, common, age of, 237.  
 — anatomy of byssus and foot, 244.  
 — conditions favourable and unfavourable to growth of, 235.  
 — development of reproductive organs of, 221.  
 — growth of, 221, 233, 237.  
 — mature eggs of, 229.  
 — maturity of, 228.  
 — movements of, 242.  
 — spawning of, 229.  
 — horse (*Modiolus modiolus*), growth of, 233.  
 — spawning of, 232.  
*Mytilus edulis*. See Mussel, common.  
*Nogagus ambiguus*, 217.  
 — *cranchi*, 216.  
 — *latus*, 216.  
*Notopterophorus papilio*, 212.  
*Nyctiphanes norvegica*, 261, 263, 264, 266, 267.  
*Oithona similis*, 262, 267, 268.  
*Pandarus*, 216.  
 — *carcharias*, 216.  
*Parathemisto*, 266.  
 — *oblivia*, 266, 267.  
 Peterhead district, fluctuations of herring fishery in, 97.  
 Piked dog-fish (*Squalus acanthias*), 217.  
 Plaice, hatching of, 256.  
*Pseudocalanus*, 269.  
 — *elongatus*, 264, 267, 268.  
*Rhoda*, 268.  
 Rothesay district, catch of herrings within limits of, 1863-1887, 109.  
 — course of herring fishing in, 32.  
 — limits of, 31.

- |   |  |
|---|--|
| <p>Rothsay district, statistics of herring fishery in, 31.</p> <p><i>Sagitta</i>, 264, 267, 269.</p> <p><i>Schistomysis spiritus</i>, 268.</p> <p><i>Siriella</i>, 268.</p> <p>Sound of Kilbrennan, herring fishing in, 63-76.</p> <p>Spawning of common mussel, 229.</p> <p>— of horse mussel, 232.</p> <p>— of herrings on Ayrshire coast, 47.</p> <p>Spent herrings, chemical composition of, 201, 203, 205.</p> | <p>Spout-fish (<i>Solen siliqua</i>), growth of, 251.</p> <p><i>Squalus acanthias</i>, 217.</p> <p>Stornoway herrings, food of, 265.</p> <p>TECHNICAL instruction to fishermen, 7.</p> <p><i>Temora</i>, 269.</p> <p>— <i>longicornis</i>, 262, 267, 268.</p> <p><i>Thysanoessa</i>, 262, 267, 268.</p> <p>WEST coast, fluctuations in herring fishery on, 98.</p> |
|---|--|



